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Measurements of Fission and Activation Products for Oak Ridge National Laboratory Transuranic Waste Characterization

L. K. Nguyen
L. F. Miller
D. J. Downing

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ORNL/TM-13292

Instrumentation and Controls Division

MEASUREMENTS OF FISSION AND ACTIVATION PRODUCTS FOR OAK RIDGE NATIONAL LABORATORY TRANSURANIC WASTE CHARACTERIZATION

L. K. Nguyen
L. F. Miller
D. J. Downing

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OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831-6285
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ACRONYMS

ALARA	as low as reasonably achievable
APNEA	active passive neutron examination and assay
ARMD	Applied Radiation Measurements Department
CH	contact handled
DA	destructive assay
DOE	U.S. Department of Energy
GASP	gamma assay segmented passive (system)
GCO	generator certification official
HFIR	High Flux Isotope Reactor
HPGe	High purified germanium (detector)
INEL	Idaho National Engineering Laboratory
LAA	limited access area
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
NDA	nondestructive assay
NTP	National TRU Program
NTS	Nevada Test Site
ORNL	Oak Ridge National Laboratory
PTS	Progress Tracking System
QAPP	Quality Assurance Program Plan
REDC	Radiochemical Engineering Development Center
RFETS	Rocky Flats Environmental Technology Site
RH	remote handled
SNL	Sandia National Laboratory
SRP	Savannah River Plant
TRU	transuranic
WAC	waste acceptance criteria
WEAF	Waste Examination and Assay Facility
WIPP	Waste Isolation Pilot Plant
WMRAD	Waste Management and Remedial Action Division

NOMENCLATURE

a	alpha-emitting radionuclides: ^{252}Cf, ^{246}Cm, ^{238}Pu, Pu* , ^{242}Pu, and ^{243}Am
A_α	alpha activity
A_γ	gamma activity
A(g)	activity of gamma-emitting radionuclide (g) measured from the GASP system
A_p (a,g)	activity of radionuclide (a) at the pth percentile based on radionuclide (g) measurement
$A_{\hat{\mu}}(a,g)$	activity of radionuclide (a) based on the estimated mean activity ratio $\hat{\mu}$
$cv^2(a,g)$	coefficient of variation of the arithmetic mean activity ratio X_{avg} (a,g)
g	gamma-emitting radionuclides: ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{134}Cs, ^{152}Eu, and ^{137}Cs
GM(Y)	geometric mean of activity ratio X(a,g) based on $\bar{Y}$
GSD(Y)	geometric standard deviation from the geometric mean GM(Y)
I	statistical order of an observation calculated for each activity ratio set; or the order number defining the lower bound of uncertainty associated with a pth percentile
k	order number defining the upper bound of uncertainty associated with a pth percentile
m	total number of observations for an activity ratio set
p_i	probability that a variable x_i will fall within the ith percentile value
R_p (a,g)	activity ratios of a homogenous mixture of REDC solid TRU wastes
s_Y^2	sample variance of the arithmetic average activity ratio $\bar{Y}$
$s^2(\hat{\mu})$	variance of the estimated mean activity ratio $\hat{\mu}$
w(a,g)	weighting factors based on the uncertainty associated with the activity ratio X_p(a,g)
X_p (a,g)	activity ratio between radionuclides (a) and (g) at the pth percentile from the cumulative distribution function (CDF) plot
X_{avg} (a,g)	arithmetic average of individual set of activity ratios of radionuclide (a) over (g)
$\bar{Y}$	arithmetic average of individual set of the log of activity ratios Y_p (a,g)
Y_p (a,g)	log of the activity ratio between radionuclides (a) and (g) at the pth percentile
μ	mean activity ratio of the untransformed (lognormal) activity ratio X_p (a,g)
$\hat{\mu}$	estimated value of the mean activity ratio μ
μ_Y	true mean activity ratio of the transformed (lognormal) activity ratio Y_p (a,g)
σ^2	variance of the untransformed (lognormal) activity ratio X_p (a,g)
$\hat{\sigma}$	estimated value of the standard deviation σ
σ_Y^2	true variance of the transformed (lognormal) activity ratio Y_p (a,g)
s_A (a,g)	standard deviation from the estimated mean activity $A_{\hat{\mu}}(a,g)$
σ_{avg} (a,g)	standard deviation from the arithmetic mean activity A_{avg} (a,g)

EXECUTIVE SUMMARY

It is beyond the current nondestructive analysis (NDA) state-of-the-art to accurately measure important alpha- and beta-emitting radionuclides in the presence of typically-occurring background levels of neutron and photon radiation associated with remote handled (RH) transuranic (TRU) waste; in addition, it is not economically feasible to perform destructive analyses (DA) that employ radiochemical techniques on representative random samples from each waste container designated for disposal. Techniques that utilize gamma spectroscopy cannot measure purely alpha-emitting radionuclides, and they are difficult for measurements of photon-emitting radionuclides in large containers with energies below about one hundred keV. The methodology presented in this report combines gamma spectroscopy measurements of waste canisters with radiochemical analyses of smear samples and with statistical analyses to obtain estimates of alpha-emitting radionuclides in waste containers. This approach, with some additional research, is expected to provide an effective and practical technique for characterization of TRU radioactive waste to meet the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria (WAC) and for segregating waste at the Radiochemical Engineering Development Center (REDC).

Briefly, this approach uses gamma spectroscopy to obtain activities of "easy-to-measure" fission and activation products to estimate the activities of various alpha emitters. Easy-to-measure radionuclides are those for which conditions such as attenuation by the waste matrix, interference by other radionuclides, and uncertainties associated with branching ratios introduce no more than 10 % error in the estimate of the activity. Ranked ratios of alpha-to-gamma emitters are used to construct cumulative distribution functions (CDFs), and the 0.5 fractiles of these CDFs are suggested for use as the estimator for the ratio of specific alpha-emitting to gamma-emitting radionuclides. The overall procedure for implementing this methodology is as follows:

1) Obtain radiochemical analyses of at least 50 smear samples. These analyses must include all alpha-emitting radionuclides of interest and all gamma-emitting radionuclides expected to be used in the gamma spectroscopy.

2) Calculate ratios of measured activities of alpha-emitting to gamma-emitting radionuclides proposed for use in the statistical analyses. Rank the ratios for each combination of alpha-emitting to gamma-emitting radionuclides and construct CDFs for each combination. Data reported as less than a given value (nondetects) should be ranked based on judgement of the analyst. Regardless of the ranking of the nondetects, measured values greater than the less than values will have the correct probability assignments.

3) Measure activities of gamma-emitting radionuclides in a drum using measurement protocols verified to be correct through calibrations with isotopes of interest in geometrical configurations and compositions similar to the waste container.

4) Multiply measured activity times the 0.5 fractile of the CDF for each alpha-emitting to gamma-emitting radionuclide of interest to estimate the total activity of each alpha-emitting radionuclide in the drum. The estimated value for a given radioisotope is the average, or weighted average, of the estimates from each of the "easy-to-measure" radionuclides. The uncertainty of the estimate can be obtained directly from the confidence intervals that bound the 0.5 fractiles of the smear sample CDFs; however, the

use of confidence intervals from smear CDFs should considerably over predict the uncertainty of the estimate for buckets or drums since confidence intervals of CDFs from populations of buckets and drums should be much smaller than those from populations of smears.

An evaluation of this approach was accomplished for newly generated TRU waste in cubical nine of the Radiochemical Engineering Development Center (REDC) at Oak Ridge National Laboratory. The REDC has irradiated several types of targets in the High Flux Isotope Reactor (HFIR) to produce ^{252}Cf and other isotopes, but most of the stored waste in cubicle nine is believed to be from a single campaign. Chemical processing of targets irradiated in the HFIR selectively removes some isotopes to liquid waste streams; hence, the concentration of these isotopes appear in the solid waste with relatively less activity than in the targets when they are removed from the HFIR, which can be calculated and measured. This processing, however, does not impact the results of this study since the smear samples are obtained directly from the waste characterized.

Chemical processing and physical dispersion mechanisms change these relative values as a function of space and time in a manner which is assumed to be random. Thus, the random variables in this study are selected to be the relative concentrations of alpha-emitting to gamma-emitting radionuclides as driven by chemical and physical dispersion mechanisms. Measurements obtained from radiochemical analyses are assumed to be deterministic values; hence, no experimental uncertainty is included in these data.

In some cases, the chemical and physical dispersion mechanisms of alpha- and gamma-emitting radionuclides may be very similar. For this case, one expects to find good correlations in the concentrations among smear samples. If dispersion mechanisms differ significantly, correlations may be weak or not exist. One limitation of the current study is that many of the results from radiochemical analyses are reported as less than a given value rather than a specific value with an associated uncertainty (referred to as nondetects). Data sets with many nondetects generally show poor correlation whereas other data sets show modest correlation among alpha-emitting to gamma-emitting radionuclides. Methods for rigorously treating nondetects for determining correlations may provide an improved understanding of relationships among alpha-emitting and gamma-emitting radionuclides.

One advantage of the method developed in this study is that uncertainties associated with estimates of the concentration of alpha-emitting radionuclides can be obtained with or without determining correlations or finding calibration models. In particular, the degree of correlation is reflected in the slope of the CDFs near the 0.5 fractile, and calibration functions are not necessary. If the correlation is perfect, the associated CDF is a vertical line, and there is no uncertainty in the estimate; however, the confidence intervals about the 0.5 fractiles of the CDFs of ratios increase as the correlation decreases, and the CDFs become flatter. Correlations among constituents in all waste forms should be, in general, modest to weak; thus, it may not be prudent to commit a large effort to optimizing calibration models.

Another important positive feature of the proposed approach is that estimates based on CDFs for buckets and drums should contain much less uncertainty than those based on smear CDFs. In the case of very small samples, in mass and activity, the variability of radionuclides found in any particular location is large, but this variability should decrease for populations with members of increasing mass. It is expected that the 0.5 fractile for a population of smear samples is the same as

for populations of buckets and drums, but this remains to be proven. If this is the case, the estimated activity for any given container may differ significantly from the actual value, but the predicted and actual values should converge as the number of containers and isotopic estimates increase. Thus, the total predicted inventory for many containers (about 50) should be very accurate even though the difference between estimated and actual contents for any given container could differ significantly. One approach for determining the variability between estimated and actual activities in containers of various sizes from various waste streams is to simulate waste packages and measurement systems to obtain data for evaluating statistical analysis methods. Another is to conduct relatively inexpensive experiments using gamma spectroscopy to obtain CDFs of photon-emitting radionuclides for bucket- or drum-size accumulations of mass and to use these results for the alpha-emitting radionuclides.

The approach described above is tested on one relatively small (bucket) waste container. The TRU activity obtained by ashing bucket 6120 is reported to be 507 nCi/g with no uncertainty estimate included. Estimates based on the gamma spectroscopy measurements for ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{134}Cs, ^{154}Eu and ^{137}Cs (in combination with the 0.5 fractile of the associated CDF) are 876, 263, 3752, 532 1,024 and 388 nCi/g respectively. The arithmetic average of these estimates is 1140 nCi/g, which is about a factor of two higher than the value based the radiochemical analysis of the ashed bucket.

Nearly all of the 54 CDF plots visually appear to be lognormally distributed between the 0.1 and 0.9 fractiles, but proof of lognormality is complicated by the fact that many of the data are in the form of inequality statements rather than values with reported uncertainties. However, if one assumes lognormality as determined from CDF plots between the 0.1 and 0.9 fractiles, the geometric standard deviation is easily determined, and typical values are about three. If the estimates from the six "easy-to-measure" radionuclides are averaged, and if they are unbiased, predictions from the smear sample data should be within about a factor of two (one sigma). The CDF plots for buckets and drums should be much steeper, however, and the methodology should be much more accurate for these canisters.

Measured activities of gamma-emitting radionuclides in bucket 6120 determined from radiochemical analyses and from gamma spectroscopy differ from about a factor of two (^{154}Eu) to a factor of fifty (^{125}Sb). Ratios of activities of gamma-emitting radionuclides, as determined from radiochemical analyses, generally differ from those obtained from gamma spectroscopy by more than a factor of three. Those that involve ^{125}Sb differ by as much as a factor of about thirty. Thus, the discrepancy between measurement techniques exceeds the uncertainty of the prediction of the statistical analysis methodology. Consequently, the protocols for radiochemical analyses of buckets and for gamma spectroscopy of buckets must be improved (and validated) to obtain meaningful data for evaluating statistical analysis methods.

Several issues need additional study. One is the assumption that the 0.5 fractile is invariant with mass of members from populations of smears, buckets and drums. Another is the validity of the gamma spectroscopy and radiochemical measurements. A third is the number of gamma-emitting radioisotopes that can be accurately measured. This is important since the accuracy of the prediction of the average activity improves as a function of the square root of the number of unbiased estimates. The uncertainty in the estimate could be further reduced by including results from neutron interrogation experiments and by inverse variance weighting of these results with those from gamma spectroscopy. A fourth item that needs additional research is the determination of the uncertainty, or the shape of the CDFs, as a function of smear, bucket and drum populations.

1. INTRODUCTION

1.1 BACKGROUND

The U.S. Department of Energy (DOE) has operated numerous facilities throughout the United States for nuclear and nonnuclear research, development, and production. As a result of these operations, many types of waste have been buried in the ground throughout the DOE complex in the past 40 to 50 years. These legacy wastes must be retrieved and characterized for future safe disposal. In addition, newly generated wastes from current research projects are being generated and stored at DOE facilities. These waste streams must also be properly classified and packaged to ship to a final waste disposal site.

DOE Order 5820.2A defines transuranic (TRU) wastes as those containing alpha-emitting transuranium radionuclides with half-lives of more than 20 years and concentrations higher than 100 nCi/g at the time of assay.[1] Specifically, the transuranic radionuclides of interest are: ^{235}Np, ^{236}Np, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu, ^{244}Pu, ^{241}Am, ^{242}Am, ^{243}Am, ^{243}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, ^{248}Cm, ^{250}Cm, ^{247}Bk, ^{249}Cf, and ^{251}Cf. Based on the nature of DOE operations, some of the DOE facilities generate a large amount of TRU or mixed TRU wastes. Facilities participating in the DOE national TRU waste program include Argonne National Laboratory-East, the Hanford Reservation, Idaho National Engineering Laboratory (INEL), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), the Nevada Test Site (NTS), Oak Ridge National Laboratory (ORNL), Rocky Flats Environmental Technology Site (RFETS), Sandia National Laboratory (SNL), and the Savannah River Plant (SRP). As discussed in the Proposed Site Treatment Plans National Summary Report, except for ORNL, these DOE sites have collected characterization data and have identified appropriate treatment technologies to process most of their TRU waste streams for final disposal.[2] Furthermore, both the Argonne and Rocky Flat sites indicate that approximately 25 to 35% of their TRU waste requires no treatment to meet the waste acceptance criteria (WAC) of the final waste disposal site.

Per DOE policy, all DOE defense TRU wastes must be shipped to the Waste Isolation Pilot Plant (WIPP) for final disposal. As a result, major DOE sites are planning to treat their wastes on site to meet WIPP WAC.[3] For economic reasons, DOE facilities that generate small amounts of TRU wastes propose to package and transport their wastes to another DOE site for further processing to meet WIPP WAC. The WIPP Quality Assurance Program Plan (QAPP) states that each stored TRU waste site can either use a combination of process knowledge and limited radiochemical analysis or develop nondestructive assay (NDA) systems to characterize each waste stream.[4] For newly generated wastes, DOE's WIPP requires that the waste generator (a) provide methods for sampling and analyzing waste streams to establish an acceptable-knowledge baseline, and (b) develop a recurring sampling plan that will ensure that the data quality objectives can be met.[5] Regardless of how characterization data are obtained for an individual waste stream, each waste generator must validate the characterization data with NDA measurements to meet the WIPP WAC.

Analytical methods used for characterizing TRU wastes at DOE sites are divided into two categories: radiochemical analysis and NDA.[6] Radiochemical analysis is often referred to as destructive assay (DA) because the waste sample will not retain its original structure after the analysis is completed. A typical DA includes a gross alpha counting, an alpha pulse-height analysis, mass spectrometry analysis, and a gamma scan. The analytical results obtained from radiochemical test methods can be

produced more precisely and accurately than results from NDA methods. However, the waste must be sorted and reduced to a homogeneous mixture before samples are taken for radiochemical analysis. This process must be followed to obtain representative DA samples of an individual waste stream. Consequently, this practice may not meet the as-low-as-reasonably-achievable (ALARA) requirements because of excessive personnel exposure time during the sample collection and processing period. DA results are also expensive. Therefore, waste generators often use the "process knowledge" option with radiochemical analyses to fully characterize their waste streams and reduce the cost associated with the sampling activities.[5]

NDA is defined as "the observation of spontaneous or simulated nuclear radiations, interpreted to estimate the content of one or more nuclides of interest in the item assayed, without affecting the physical or chemical form of the material." NDA includes passive gamma, passive neutron coincidence counting, passive active neutron assay, and calorimetry. NDA has been reliable and accurate in determining fissile, radionuclide, alpha curie content, and decay heat values of contact-handled* (CH-TRU) wastes.[6] NDA techniques are still in the developmental phase for characterizing remote-handled† (RH-TRU) wastes because the NDA instruments that are commercially available cannot withstand the high radiation environment. These NDA methods are more desirable since NDA measurements can be taken without opening individual waste packages. In addition, they are less expensive and can reduce personnel exposure. Table 1 provides CH-TRU waste characterization methods used by individual DOE sites.[6]

Along with the technical and compliance-related issues, an important consideration in the identification of radioactive waste as low level or TRU is cost; this is because of the highly disparate disposal costs for low level waste vs TRU waste. Current estimates suggest that the disposal costs for TRU waste may be a factor of 10 more than that of low level waste per unit volume. Thus, during the waste characterization process it is very critical that radioactive waste is accurately identified as low level or TRU to avoid any unnecessary cost penalties while ensuring compliance with regulations. The data examined in this report came mainly from the solid wastes generated from Building 7920 of the Radiochemical Engineering Development Center (REDC) because approximately 90% by volume of the legacy ORNL RH-TRU wastes were generated by this facility. Newly generated REDC waste represents 100% of the ORNL RH-TRU inventory.

REDC was used for the production, storage, and distribution of radioactive heavy elements. This facility has been the major generator of RH-TRU wastes at ORNL since operation of the facility began in 1965. The main components of REDC wastes are reported to be ^{244}Cm and ^{252}Cf, which are not TRU radionuclides according to the DOE definition.[1] In 1991, ORNL petitioned Department of Energy-Oak Ridge Operations (DOE-ORO) to include ^{244}Cm and ^{252}Cf as TRU waste radionuclides because of their uniqueness to ORNL waste management concerns such as difficulty in assaying and the need for special handling associated with neutron emissions. To date, DOE-ORO has not approved this request. Through process knowledge, fission products and a small amount of other TRU radionuclides were also identified in the waste stream. However, it is not known whether the total concentrations of TRU nuclides in waste containers are above the 100 nCi/g limit. Considering the large inventory of REDC legacy waste, it is imperative that a correct determination be made

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* All TRU wastes generated at ORNL that have an external dose rate $\leq$ 200 mrem/h are classified as CH-TRU wastes.

† By definition, RH-TRU wastes have an external dose rate >200 mrem/h.

regarding the classification of REDC wastes so that a proper waste management plan can be implemented.

Table 1. Summary of assay methods used at DOE contractor sites for characterization of contact-handled transuranic wastes[a, 6]

DOE sites	SGS or NaI [b]	PNCC[c]	PAN[d] (drum)	PAN[d] (box)	Radio-chemistry	Mobil PAN
Argonne National Laboratory - East	X			X		
Westinghouse Hanford Corp.	X		X			
Idaho National Engineering Laboratory			X	X		
Los Alamos National Laboratory	X	X	X		X	X
Lawrence Livermore National Laboratory	X				X	X
EG & G Inc., Mound Facility	X				X	
Nevada Test Site						X
Oak Ridge National Laboratory	X[e]		X[e]			
Rocky Flats Plant	X	X	X	X	X	
Savannah River Plant	X	X	X			

[a] *The calorimetry method is also used to obtain quantitative radionuclide content.*
[b] *SGS - segmented gamma scan; NaI - sodium iodine detector.*
[c] *PNCC - passive neutron coincidence counting.*
[d] *PAN - passive-active neutron assay.*
[e] *ORNL currently uses the following NDA systems:*
(a) gamma assay segmented passive (GASP) system instead of the SGS.
(b) active passive neutron examination and assay (APNEA) system instead of the PAN.

1.2 OBJECTIVES AND METHODS

The objectives of this report are to determine if a waste container generated from REDC can be classified as TRU and to provide an appropriate method of estimating the initial TRU concentration in this container. Gamma spectroscopy method alone cannot be used effectively to identify alpha-emitting radionuclide in the presence of a high-flux of gamma-ray emitted from the fission and activation products. Current available neutron assays are also designed for measurement of weapon-grade plutonium and has not been adjusted to handle a large gamma dose rate. For these reasons, neither gamma spectroscopy nor neutron assay can be used without major modifications to quantify the alpha-emitting radionuclides contained in REDC wastes. The methodology presented in this report

combines gamma spectroscopy measurements of waste package with radiochemical analyses of smear samples and with statistical analyses to obtain estimates of alpha-emitting radionuclides in waste containers.

A pilot study was performed in fiscal year 1995 to obtain radiochemical analysis from various types of REDC solid cell wastes. Preliminary assessment of this pilot study data suggested that there is a good correlation between TRU alpha emitting radionuclides (^{246}Cm, ^{238}Pu, $^{239/240}Pu$, ^{242}Pu, ^{241}Am, and ^{243}Am) and the "easy-to-measure" gamma emitting radionuclides such as ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{134}Cs, ^{154}Eu, and ^{137}Cs. "Easy-to-measure" radionuclides are those for which conditions such as attenuation by the waste matrix, interference by other radionuclides, and uncertainties associated with branching ratios introduce no more than 10% error in the estimate of the activity. Given the current NDA measurement capabilities at ORNL, a Gamma Assay Segmented Passive (GASP) system can be used accurately to measure the activity of these gamma-emitting radionuclides in a containerized waste. The TRU alpha activity in a waste container can be determined by multiplying the measured gamma activities with the TRU alpha-to-gamma activity ratios calculated from the pilot study data. Non-parametric and parametric statistics will be used to establish the upper and lower confidence limits associated with individual activities ratios calculated from radiochemical analysis. Both the radiochemical analysis and GASP measurements obtained from an REDC bucket containing melted polyethylene type of wastes will be used to illustrate the effectiveness of this characterization approach.

2. DESCRIPTION OF REDC WASTE STREAM

2.1 REDC MAIN STREAMS PROCESSING

REDC consists of Buildings 7920 and 7930, which were constructed in the mid-1960s. Building 7920 is used for the production, storage, and distribution of radioactive heavy transplutonium elements: Fermium (Fm), Einsteinium (Es), Berkelium (Bk), Americium (Am), and Curium (Cm). Building 7930 is used exclusively for purifying and packaging ^{252}Cf. Transplutonium radioisotopes, particularly ^{252}Cf, are produced for use in medical and industrial applications, for research on the properties of heavy elements, and for production of super-heavy elements (i.e., those elements with atomic numbers above 104). This report focuses on wastes generated from Building 7920 because of the diverse nature of the waste compositions produced from the main operational process in this building.

Building 7920 contains nine heavily shielded hot cells that house equipment for high-radiation-level radiochemical processing and target fabrication activities. In addition, this building is equipped with eight laboratories that are used for process development, process-control analyses, and final transuranium element product purification and packaging operations. The general layout of the hot cells area located in this building is shown in Fig. 1.[7]

The REDC facilities recover and purify transplutonium elements from nuclear fuel rods irradiated in the High Flux Isotope Reactor (HFIR targets) or in the SRP reactors (Mark-42 targets). Transuranium element processing in Building 7920 includes dissolutions of irradiated targets, separation of the transuranium elements from miscellaneous impurities and fission products, and separation of the transuranium elements from each other. This is accomplished by the application of a variety of solvent extraction, precipitation, and ion-exchange processes that are performed in a sequence called a *processing campaign*. A campaign typically runs between 8 months to a year to extract the desirable products from a set of 12 to 15 target rods. Depending on the desired final products, each campaign may use either irradiated HFIR or Mark-42 targets as the "feed materials." Irradiated HFIR targets were used in almost every campaign during the past 15 years to recover ^{252}Cf and other heavy transuranium elements. Mark-42 targets, imported from the SRP, were used in some isolated campaigns to increase the REDC supply of ^{244}Cm, ^{243}Am, and ^{242} Pu.[244] Curium and ^{243}Am radionuclides are produced at REDC for making the fuel elements in the HFIR targets. A typical process diagram for processing HFIR targets was updated to match the current operation process and is included in Fig. 2.[7] A typical Mark-42 target process diagram is shown in Fig. 3 for completeness.[8] Before the start of each campaign, the computer code ORIGEN2 is used to calculate the activities of fission and activation products present in the target's materials. The activity data are then used to predict the total amount of heavy elements that can be recovered at the end of each campaign. As an example, the feed compositions used in Campaign 69 (started in August 1994) are listed in Table 2. Leaching solutions from the hot cell and equipment cleanup activities, accumulated from the previous campaign, are added to the current campaign as the "rework" feed stream to extract additional valuable products. Isotopic ratios of transuranium elements in REDC actinide processing streams are determined by performing radiochemical analyses on liquid samples pulled at various stages of a processing campaign. The "material balance" calculations are also performed at these "checkpoints" to determine the efficiency of each chemical extraction and purification process. Based on Fig. 2, the activity ratios among all radionuclides processed at REDC are expected to vary within a given campaign because of the elemental separation process. After the rework materials are introduced to the main stream processing, the isotopic ratio for an element in a given campaign should not change

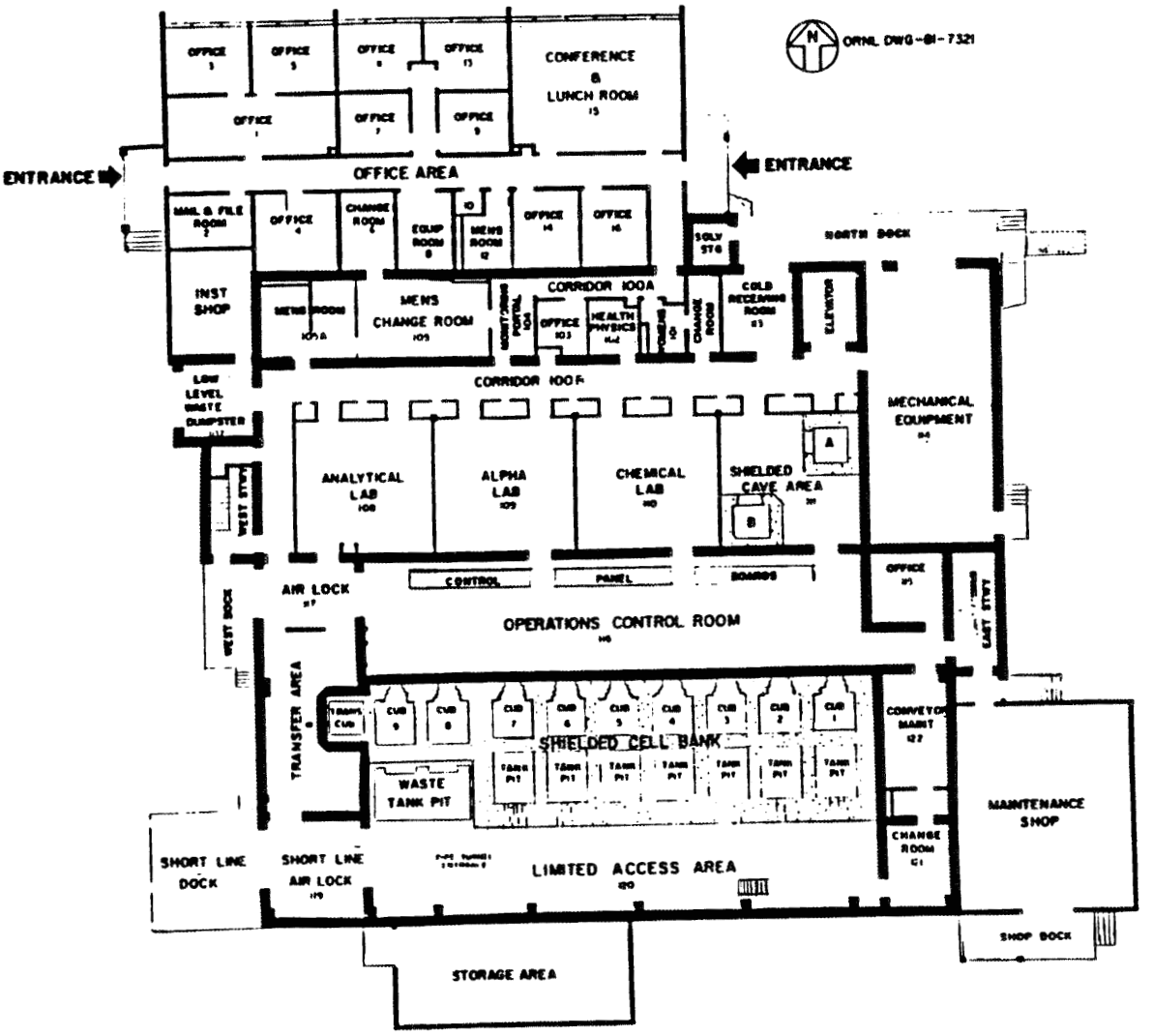

Fig. 1. Transuranium processing plant (TRU) Building 7920.

SOURCE: E. D. Collins and J. E. Bigelow, *Chemical Processing Practices and Equipment in the Transuranium Processing Plant after 10 years of Operation*, Proceeding of the 24th Conference on Remote Systems Technology, pp.118-129, 1976.

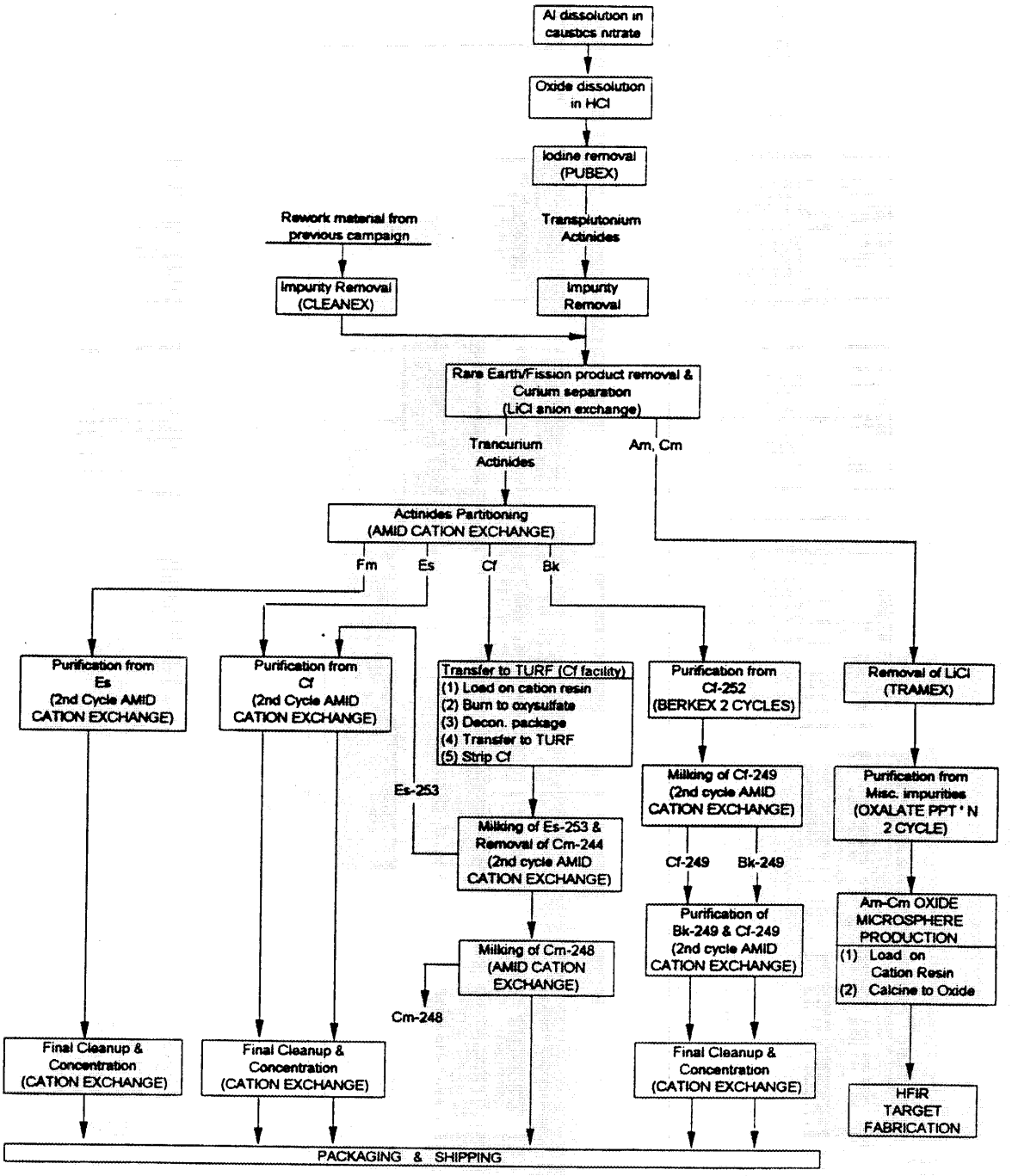

Fig. 2. Processing diagram for a typical HFIR target campaign at REDC.

SOURCE: E. D. Collins and J. E. Bigelow, *Chemical Processing Practices and Equipment in the Transuranium Processing Plant after 10 years of Operation*, Proceeding of the 24th Conference on Remote Systems Technology, pp.118-129,1976.

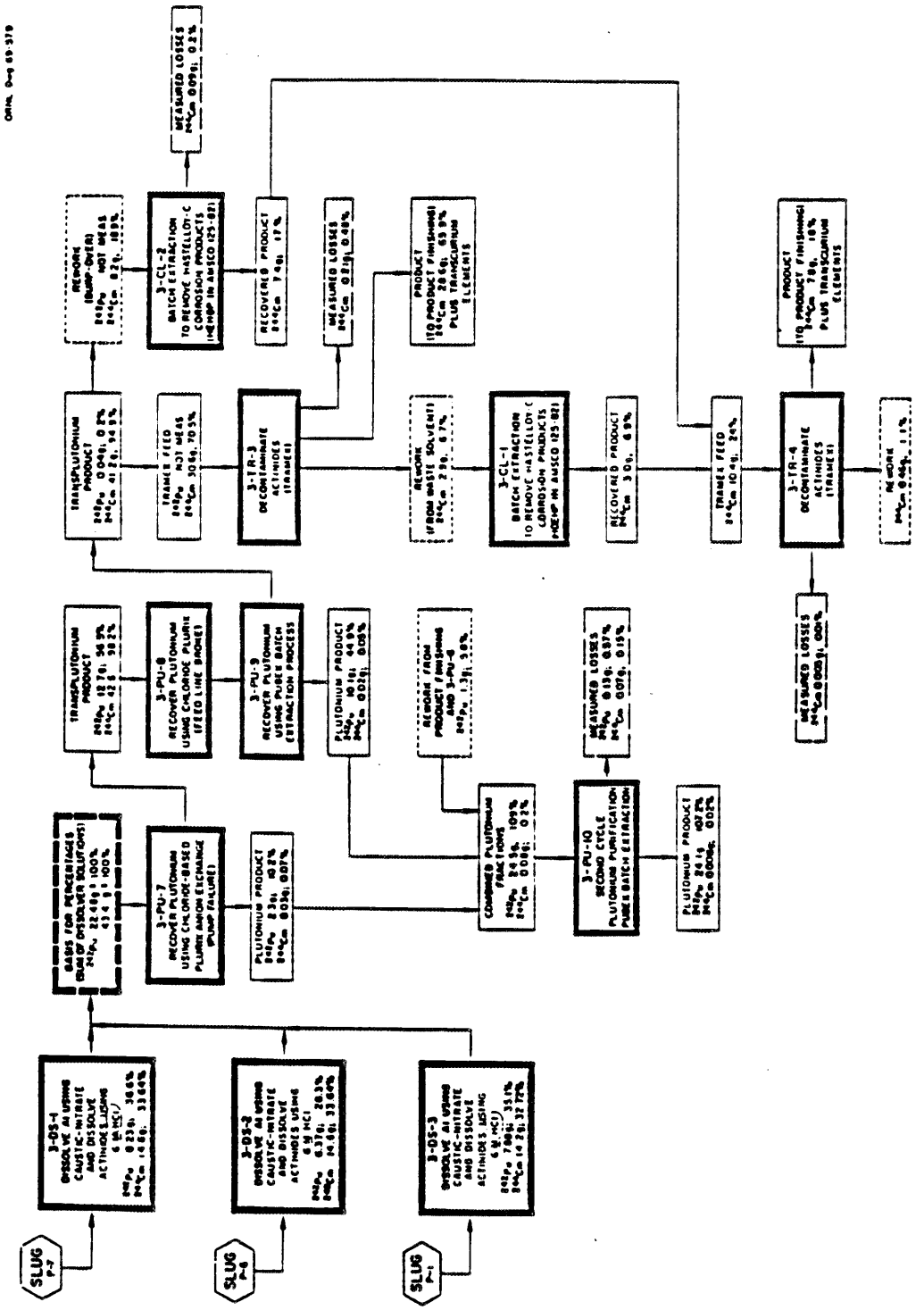

Fig. 3. Typical processing diagram for a group of Mark-42 targets at REDC.

SOURCE: L. J. King, and E. D. Collins, *Summary of the Campaign to Process Six SRP Reactor Slugs in the Transuranium Processing Plant*, ORNL/TM-1939, April 1969.

Table 2. Initial feed conditions for Campaign 69[a]

Feed material	^{131}I (Ci)	^{241}Am (g)	^{243}Am (g)	Cm (g)	^{244}Cm (g)	^{249}Bk (mg)	^{252}Cf (mg)	^{253}Es (μg)
12 HFIR targets	250		0.11	76.3	14.7	66.9	467.5	3.64
Accumulated rework solution[b]		3.0	6.4	29	13	0.3	18	
Total	250	3.0	6.5	105.3	27.7	67.2	485.5	3.64

[a] Internal memorandum from L. K. Felker to distribution, *Plan for Campaign 69: Processing of Twelve Curium Targets plus rework materials*, August 26, 1994.

[b] Accumulated rework solution consists of liquid materials collected during the previous campaign that still contain excessive amounts of valuable products (such as ^{252}Cf).

since there is no additional feed material introduced to the main stream process. However, isotopic ratios derived at one point in time have to be corrected to account for the natural nuclear decay process. For this reason, REDC staff usually combine the mass spectroscopy results taken from the rework stream and the calculated activity data derived from the target materials to establish the index ratio of ^{244}Cm and ^{252}Cf for use throughout an individual campaign. Tables 3 and 4 provide the isotopic ratios of curium and californium radionuclides present in the main operations of Campaign 69.

REDC main line operations are normally carried out in one of the nine shielded cells located on the first floor of Building 7920. Each cell (1 through 9) consists of a cubicle area, cubicle pit, and waste tank pit. Since the cubicle pits and waste tank pits are self-contained, REDC RH-TRU solid wastes are expected to be generated only from the cubicle areas. As shown in Fig. 4, each cubicle is used for a specific process. Cubicles 1 through 3 are used for HFIR target fabrication: the first cubicle is used for preparation of the pellets, the second cubicle is used for loading and welding the tube, and the third cubicle is designated for target inspections. Cubicles 4 through 7 are used for chemical process operations. Cubicle 8 is used to dilute samples taken from various process streams. Small aliquots of diluted samples are taken to the radiochemical laboratory for preparation and counting. Currently, cubicle 9 is used as a temporary waste-storage area. Based on these observations, contamination in cubicles 1 through 3 is expected to be mostly airborne particulates since these cubicles are dedicated to HFIR target fabrication activities. Isotopic distributions of wastes, generated from cubicles 4 through 7, will be proportional to the isotopic profiles of chemical processes taking place within individual hot cell areas. The isotopic profiles of these chemical processes can potentially be characterized based on the type of nuclear fuel targets that were used during a particular campaign (i.e., HFIR targets or Mark-42 targets) because of the different types of feed materials used in each type of campaign.

Table 3 Curium isotopic ratios for Campaign 69 based on C-68 rework and C-69 target estimates[a]

Rework from 68-CL-8

Mass analysis on: 9/30/94
Cm-244 content: 15.9 g

Isotopes	AT %	WT %
Cm-242	0.00	0.00
Cm-244	49.23	48.99
Cm-245	1.21	1.21
Cm-246	41.44	41.58
Cm-247	1.14	1.15
Cm-248	6.98	7.06

Avg. MW = 245.16

C-69 Targets

Est. analysis on: 9/30/94
Cm-244 content: 14.37 g

Isotopes	AT %	WT %
Cm-242	0.67	0.66
Cm-244	21.71	21.55
Cm-245	0.25	0.25
Cm-246	63.03	63.08
Cm-247	1.70	1.71
Cm-248	12.64	12.75

Avg. MW = 245.87

Campaign estimates based on campaign 68 rework and target estimates

Isotopes	Total WT	WT %
Cm-242	0.439	0.44
Cm-244	30.208	30.53
Cm-245	0.559	0.56
Cm-246	55.458	56.05
Cm-247	1.510	1.53
Cm-248	10.776	10.89

[a] Data presented in Tables 3 and 4 was provided by the REDC technical group.

Table 4. Californium isotopic ratios for Campaign 69 based on C-68 rework and C-69 target estimates[a]

Rework from Campaign 68

Mass analysis on: 02/04/93
Cf-252 content: 0.0207 g

Isotopes	AT%	WT%
Cf-249	20.080	19.908
Cf-250	10.760	10.711
Cf-251	3.700	3.698
Cf-252	65.460	65.682
Cf-253	0.001	0.001
Cf-254	0.001	0.001

Avg. MW = 251.230

C-69 Targets

Mass analysis on: 01/04/95
Cf-252 content: 0.485658 g

Isotopes	AT%	WT%
Cf-249	4.900	4.849
Cf-250	9.750	9.687
Cf-251	2.830	2.823
Cf-252	82.470	82.591
Cf-253	0.040	0.040
Cf-254	0.010	0.010

Avg MW = 251.711

Campaign Estimates based on C-68 Rework and Target estimates

Isotopes	Total Wt.	WT%	AT%
Cf-249	0.036	6.401	6.467
Cf-250	0.057	10.155	10.219
Cf-251	0.017	3.057	3.064
Cf-252	0.449	80.378	80.241
Cf-253	0.000	0.005	0.005
Cf-254	0.000	0.005	0.005

[a] Data presented in Tables 3 and 4 was provided by the REDC technical group.

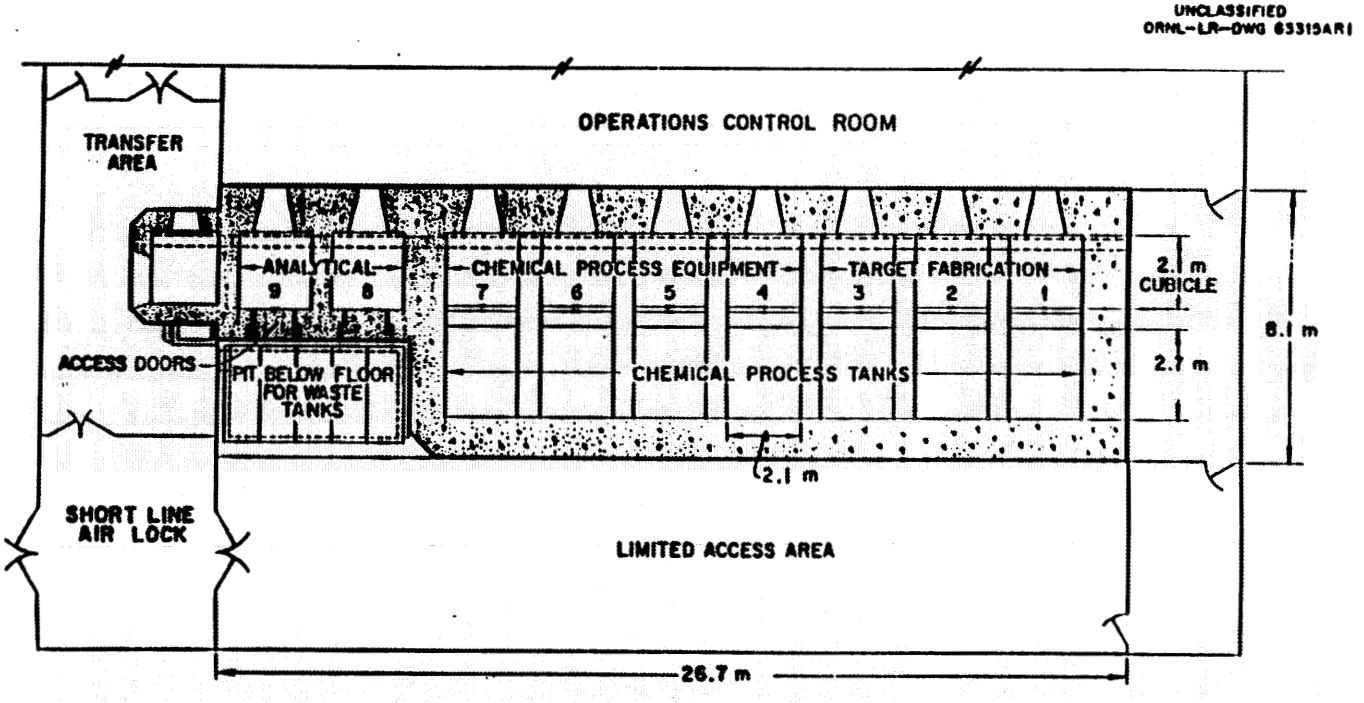

Figure 4. Plan view of shielded cell bank.

SOURCE: E. D. Collins, and J. E. Bigelow, *Chemical Processing Practices and Equipment in the Transuranium Processing Plant after 10 years of Operation*, Proceeding of the 24th Conference on Remote Systems Technology, pp.118-129, 1976.

2.2 WASTE HANDLING PROCESS

About 75% of the REDC TRU solid wastes (mostly RH-TRU) inventory is generated from cubicles 1 through 8 of the shielded cell bank. In general, bulky or very hot wastes such as high-efficiency particulate air (HEPA) filters from off-gas cleanup systems, discarded equipment racks, and heaters are transferred out through a hot cell roof plug into a shielded cask via an equipment transfer case. These discarded items are placed directly into a concrete cask without being packaged in an intermediate container.

Small solid cell waste items generated from each of the hot cells are packed in a 1.5 gallon metal can. Each of these cans is remotely transported to cubicle 9 via the intercell conveyor for temporary storage. As cubicle 9 becomes full, the content of each metal can is emptied out on two metal trays located in cubicle 9 for inspection and repackaging into another 1.5 gallon metal can.

Polyethylene bottles made up a large volume of solid wastes generated from REDC hot cell operations. Empty bottles are rinsed and transferred to cubicle 9 via the in-cell conveyor for storage. These bottles are scanned with the in-cell fast neutron instrument to ensure that all products have been recovered from these bottles. These bottles and other polyethylene waste items are normally melted in 1.5 gallon metal cans for waste volume reduction purposes.

Each metal can is placed in a heat-sealed, 3 gallon polyethylene bucket. The heat-sealing gives protective rigidity during subsequent handling. The lid has a porous vent to retain particulates while allowing gas to escape. A plastic bag is put over the bucket and is closed with a twist tie after it is pulled outside of cubicle 10 for disposal. Measurements are normally taken at 3 ft from both the metal can and the polyethylene bucket. The bucket is then transported to either a stainless-steel 55 gallon drum or a concrete cask located in the limited access area (LAA) for disposal. The decision whether to use a drum or cask as the outer waste container is based on the surface dose rate measurements of the individual waste package. If the total surface doses (gamma plus neutrons) of a bucket are $\geq$ 200 mRem/hr, the bucket would be sent to the cask for disposal as RH-TRU waste. Otherwise, the bucket would be sent to the 55 gallon drum for disposal as CH-TRU waste.

On the waste bucket level, the same procedure is used to pack RH-TRU and CH-TRU wastes removed from the hot cell areas since all cell wastes become commingled in cubicle 9 before the repackaging process occurs. Based on this observation, RH-TRU hot cell wastes should have the same waste composition and isotopic ratio as CH-TRU hot cell wastes. For CH-TRU wastes, nine buckets are stacked in three layers in each 55 gallon drum. Before Campaign 69 started, some small or irregular waste items from the hot cell were removed through a glove box on a lazy susan located in cell 10. These items were then packed in a polyethylene bag (not bucket) and placed directly in the drum. For RH-TRU wastes, the buckets are placed directly into the concrete cask in a random fashion. As a result, there is a significant amount of void space in the cask. A typical cask will hold about 60 waste buckets.

Based on the waste handling process, REDC solid wastes should not be characterized by the individual cubicle, where the waste originates from. The same distribution of radioisotopes is likely to contaminate all the waste since these wastes are well mixed when they are sorted and repackaged in cubicle 9.

2.3 PHYSICAL CONTENT OF REDC SOLID WASTES

REDC TRU wastes from Building 7920 can be divided into two categories: combustible and noncombustible wastes. The combustible wastes consist of plastics (filters, bottles, tubing, valves, etc.), cellulosic items (wipes, blotted papers, wood, etc.), manipulator boots, and elastomers used in gaskets and O-rings. Because of the nature of the main operation process, with the exception of manipulator boots, combustible materials are expected to have higher contamination levels than noncombustible materials. In particular, a large amount of radioactivity contained in the combustible materials comes from a small number of polypropylene filters disposed of from the main stream operation. REDC has disposed of one to two highly contaminated F720 filters per campaign with external dose rates of 10,000 R/h (measured at 6 in.) per filter. These filters are held in small stainless steel containers for 4 to 6 years to reduce the dose rate by decay to < 2,000 R/h measured at contact with the container. REDC also discards about 24 floor flushing filters per campaign. Dose rates for these filters range from 10 to 100 R/h. In the past few years, less contaminated filters have been mixed and melted with other polyethylene items in a paint can for disposal.

Noncombustible materials include a number of oversized waste items such as HEPA filters, tank pit wastes, iodine retention system beds, as well as equipment racks and their removable parts. Other smaller waste items include glass, tools, furnaces, calcined ion-exchange resins, stainless steel cans, waste buckets, discarded metal tubing, electrical wire, and electronic equipment. In the past, REDC has not segregated combustible from noncombustible hot cell wastes before disposal.

ORNL/TM-11050 indicates that large (metal) waste items are typically placed directly in a special cask, in which they occupy approximately 90% of the cask volume.[9] The percentage of plastic, glass, and cellulosic types of wastes for the remaining portion of this cask are 5, 3, and 2%, respectively. According to REDC personnel, these bulky items are generally disposed of after every four campaigns. REDC also generates about six RH-TRU casks per campaign that contain smaller waste items from the hot cell area. On average, each of these casks contains 60, 3 gallon polyethylene buckets.

Based on the ORNL Waste Tracking System, on average, REDC generates about 20 CH-TRU drums per campaign from the hot cell area and about 20 CH-TRU drums from other REDC operational areas. Estimated volume percentages of each waste type coming from the hot cell areas are as follows:

Waste type	Waste item	Volume
Plastics	Melted polyethylene bottles, polyethylene blocks, master-slaved manipulator (MSM) boots	(≈ 40%)
Glass	Sample bottles, glass ware	(≈ 30%)
Metals	Tools, pumps	(≈ 20%)
Cloth	Wipes	(≈ 10%)

The waste percentages by volume assigned for plastic and glass were calculated based on the number of polyethylene buckets containing melted polyethylene bottles, hot cell manipulator boots, and glass sample bottles listed in the waste inventory records for two casks: X10C930003 and X10C93023. These two casks represent 50% of the waste inventory for a typical campaign and contain small waste items generated from Campaign 69, which were recently transferred to the Waste Management and Remedial Action Division (WMRAD) for storage. The final volume percentage for each waste category is then adjusted by the generator certification official (GCO) to accurately reflect the percentage of metal and cloth wastes processed.

2.4 RADIOCHEMICAL CHARACTERISTICS OF REDC WASTES

Based on the mainstream operation process, the REDC isotopic waste profile is expected to contain a similar type of actinides, fission, and activation products present in irradiated targets processed annually at REDC. Table 5 provides a list of potential radionuclides present in REDC RH-TRU solid wastes. This table was compiled based on (a) ORIGEN2 calculations of typical irradiated HFIR and Mark-42 target compositions, (b) the process knowledge of the actinides recovery process from plant operation, and (c) the waste compositions estimated for a number of waste packages. Because in the past REDC also carried out some special research projects, which have been discontinued after FY 1983, radium and thorium isotopes were added to the list of suspected radionuclides that could be found in REDC wastes. In general, Table 5 does not include isotopes with half-lives shorter than 1 year and those alpha emitters with activities < 0.001 times the ^{239}Pu activity since these radionuclides will not be present in the waste at the time of shipping to WIPP.

For the past 15 years of REDC operations, the same chemical process has been used to recover transplutonium materials. It is expected that the same type of radionuclides will be present in the solid waste streams taken out of cubicle 9 from all REDC campaigns since HFIR targets have been the dominant source of the feed materials used in the main operational process. REDC wastes are highly commingled in cubicle 9 because these waste items were not completely emptied out of the storage area between campaigns. For this reason, the list of radionuclides potentially present in the REDC solid waste stream can be identified using the process knowledge methods described in Ref. 5. However, development of an accurate radiological concentration of solid waste for a specific campaign should be significantly more difficult than for the main processing streams because solid waste accumulations in cubicle 9 may be derived from more than one campaign's activities and the isotopic ratios of actinides in irradiated target product materials vary from campaign to campaign, particularly in regard to the concentrations of americium and curium radionuclides. In addition, the proportion of rework materials in a composite stream may not be the same among campaigns.

Table 5. List of potential radionuclides present in REDC TRU solid wastes

Alpha emitters	Beta/gamma emitters
Cm-242	Cs-134
Cm-243	Cs-136
Cm-244	Cs-137
Cm-245	
Cm-246	Bk-249
Cm-248	
	Eu-152
Cf-249	Eu-154
Cf-250	Eu-155
Cf-252	
Cf-253	Pm-147
	Ni-63
Ac-227	Fe-55
	Co-60
Am-241	I-129
Am-242m	Tc-99
Am-243	Sm-151
	Sr-90
Ra-226*	Y-90
	Sb-125
Th-228*	
Th-229*	Ru-106
Th-232*	Rh-106
Pu-238	Ce-144
Pu-239	Pr-144
Pu-240	
Pu-242	

* These radioisotopes are not expected to be present in the current campaign since radium targets are no longer processed at REDC.

3. ASSAY DATA FROM REDC HOT CELL WASTES

3.1 RADIOCHEMICAL TEST METHODS

Destructive assays refer to chemical analysis in which a sample aliquot is removed from the waste item to be assayed and is prepared for counting of alpha and/or gamma activities. Samples collected from the waste stream are subject to routine radiochemical processing such as chemical precipitation and separation to obtain a homogeneous aliquot for analysis. The prepared aliquot samples are assayed in a standard spectrometer. The original batch of TRU activities is then determined on an individual isotopic basis. Table 6 lists the available analytical methods that can be used to confirm and quantify the existence of potential radionuclides present in REDC RH-TRU solid waste streams. Gross alpha counting is normally used to determine the total alpha activity in a sample. Alpha spectrometry (or alpha pulse-height) analysis provides the percentage of activity contributed by each alpha emitter present in the sample. Likewise, gamma spectrometry can be used to provide the individual activity of gamma-emitting radionuclides in a waste sample collected for analysis. The mass spectrometry method provides the isotopic percentage distribution of a particular radionuclide in the sample. A chemical separation process must be completed before using the mass spectrometry method to remove other undesirable radionuclides in the sample. A chemical separation process is also required for quantifying the activity of a specific radionuclide with an expected concentration near the instrument detection limit.

3.2 PILOT STUDY PERFORMED ON REDC HOT-CELL WASTES

The selection of sample locations and analytical test methods was based on the knowledge obtained from the REDC main stream operations and the waste packing process that took place in cubicle 9. Two sets of samples were collected for analysis: 34 smear samples were taken for the first set, and 26 smear and 2 leach samples were taken for the second set. The first set of samples was collected from typical waste items located in cubicle 9 and from various locations in cubicles 1, 2, 3, 4, 6, and 8. No sample was taken from cell 5 because this cubicle was not used during Campaign 69. The second set of samples was taken from various waste items in cell 9 as a supplement to the first data set. Detailed sample locations and the sample tracking records are provided in Tables 7 and 8. Waste items from each category (i.e., plastics, glass, metal, and cloth) were collected from Campaign 69s wastes. Each of the waste items was selected randomly from several different polyethylene buckets to ensure that the analytical results obtained from the samples would represent a typical distribution of radionuclides in wastes generated from the hot cell areas. Because of the high radiation working environment, all samples were collected remotely using Q-tip swabs with wooden handles. After smearing the waste item surface, the Q-tip head was placed in a prelabeled sample bottle. The bottle was capped and removed from the cell bank. This procedure was used to avoid cross-contamination from the manipulator's fingers or other sources. To maximize the activity collected from each sample, the entire accessible surface of individual waste items was smeared with the Q-tip. As an example, both the inside surface and the threads of the polyethylene bottle were smeared to obtain the total surface contamination in the bottle. For the glass sample bottles, smears were taken after they have been leached and checked for neutron levels and released as waste. As an exception, smear samples were taken near the cuff area of the MSM boots where the contamination level is expected to be at

Table 6. Radiochemical test methods used in REDC solid waste characterization activities

Test methods	Nuclides analyzed for
Gross alpha, alpha spectrometry, Gamma spectrometry, gross neutron	Cm-244, Cf-252, Am-241, Am-243, Cs-134, Cs-136, Cs-137, Eu-154, Eu-155, Co-60, Np-237, Np-95, Sb-125, Es-253, Ra-226, Th-228, Th-229, Ru-106, Rh-106, Ce-144, Pr-144
TIMS[1], Pu separation	Pu-238, Pu-239, Pu-240, Pu-242
TIMS[1], Cm separation	Cm-242, Cm-243, Cm-244, Cm-245, Cm-246, Cm-248
TIMS[1], Am separation	Am-241, Am-242, Am-243
TIMS[1], ICP-MS[2], U separation	U-233, U-234, U-235, U-236, U-238
Cf separation, TIMS[1]	Cf-249, Cf-250, Cf-252, Cf-253
Sr separation	Sr-90, Y-90
Tc separation, ICP-MS[2]	Tc-99
Bk separation	Bk-249
ICP, Th separation, ICP-MS[2]	Th-228, Th-229, Th-232
Elemental Separations followed by ICP-MS[2]	Ni-63, Ac-227

[1] Thermal ionization mass spectrometry

[2] Inductively couple plasma - mass spectrometry

Table 7. Sample tracking records for the first set of the pilot study data

Sample Number	Cell Loc.	Sampling Date	Waste Category	Waste Item Description	Type of Sample
RH9AA	9	10/26/95	Plastic	Melted poly	Smear
RH9EE	9	10/26/95	Plastic	Poly valve	Smear
RH9KK	9	10/26/95	Plastic	Bottle lid	Smear
RH9LL	9	10/26/95	Glass	Sample bottle	Smear
RH9QQ	9	10/26/95	Metal	Wire	Smear
RH9SS	9	10/26/95	Cloth	Wipes	Smear
RH9A	9	1/11/96	Plastic	Melted poly	Smear
RH9C	9	1/11/96	Plastic	Melted poly	Smear
RH9D	9	1/11/96	Plastic	Bain Marie bucket	Smear
RH9E	9	1/11/96	Plastic	Social FDV poly valve	Smear
RH9F	9	1/11/96	Plastic	PVC valve	Smear
RH9G	9	1/11/96	Plastic	PVC valve	Smear
RH9H	9	1/11/96	Plastic	Light cord	Smear
RH9I	9	1/11/96	Plastic	MSM boot	Smear
RH9J	9	1/11/96	Plastic	Poly bottle lid	Smear
RH9K	9	1/11/96	Plastic	Bottle lid	Smear
RH9L	9	1/10/96	Glass	Sample bottle	Smear
RH9M	9	1/11/96	Glass	Sample bottle	Smear
RH9N	9	1/11/96	Glass	Glassware	Smear
RH9O	9	1/11/96	Glass	Filter housing	Smear
RH9P	6	1/11/96	Metal	Metal tool	Smear
RH9Q	9	1/11/96	Metal	PreAmp lead can	Smear
RH9R	9	1/11/96	Metal	Stainless steel lid	Smear
RH9S	9	10/26/95	Cloth	Wipes	Smear
RH9T	9	1/11/96	Cloth	Wipes	Smear
RH9U	9	1/11/96	Cloth	Wipes	Smear
RH9V	9	1/11/96	Cloth	String	Smear
RH1B	1	1/11/96		MSM boot	Smear
RH2B	2	1/11/96		MSM boot	Smear
RH3B	3	1/11/96		MSM boot	Smear
RH4D	4	1/11/96		Cubicle sump	Smear
RH6C	6	1/11/96		Cubicle sump	Smear
RH7D	7	1/11/96		Cubicle sump	Smear
RH8A	8	1/11/96		Cubicle sump	Smear

Total number of samples = 34

Table 8. Sample tracking records for the second set of the pilot study data

Sample Number	Cell Loc.	Sampling Date	Waste Category	Waste Item Description	Type of Sample
LN-1	9	5/1/96	Glass	Bottle	Smear
LN-3	9	5/1/96	Glass	Bottle	Smear
LN-4	9	5/1/96	Glass	Bottle	Smear
LN-6	9	5/1/96	Glass	Bottle	Smear
LN-7	9	5/1/96	Metal	Tool	Smear
LN-8	9	5/1/96	Glass	Bottle	Smear
LN-9	9	5/1/96	Glass	Bulb	Smear
LN-11	9	5/1/96	Glass	Bottle	Smear
LN-13	9	5/1/96	Glass	Bottle	Smear
LN-15	9	5/1/96	Metal	Tool	Smear
LN-19	9	5/1/96	Glass	Bottle	Smear
LN-25	9	5/1/96	Glass	Bottle	Smear
LN-26	9	5/1/96	Glass	Bottle	Smear
LN-28	9	5/1/96	Glass	Bottle	Smear
LN-33	9	5/1/96	Poly	Valve	Smear
LN-35	9	5/1/96	Poly	Bottle	Smear
LN-36	9	5/1/96	Metal	Cell	Smear
LN-38	9	5/1/96	Metal	Tool	Smear
LN-39	9	5/1/96	Metal	Cell	Smear
LN-40	9	5/1/96	Poly	Hose	Smear
LN-41	9	5/1/96	Metal	Column	Smear
LN-44	9	5/1/96	Metal	Cap	Smear
LN-46	9	5/1/96	Metal	Can	Smear
LN-48	9	5/1/96	Metal	Tool	Smear
LN-49	9	5/1/96	Metal	Socket	Smear
LN-54	9	5/1/96	Metal	Case	Smear
LN-GL	9	5/1/96	Glass	Bottles	Leach
LN-ML	9	5/1/96	Metal	Tool	Leach

Total number of samples = 28

Notes:

1. LN-ML (metal leach of a tool) has duplicate smears performed on the tool prior to leaching: LN-7 and LN-15.
2. LN-GL (glass leach for 3 bottles) has duplicate smears performed on the bottles prior to leaching: LN-1 and LN-11.
3. LN-19 and LN-28 are duplicate smears of the same glass bottle.
4. LN-36 and LN-39 are duplicate smears of a metal weighing cell.

the maximum level. The total gamma plus neutron doses were limited to 50 mR/h per sample. The neutron dose per sample was kept below 10 mR/h. These surface dose rates were established to avoid damage to analytical equipment and also to maintain personnel dose to ALARA.

The first set of samples was analyzed using gross alpha, alpha spectrometry, gamma spectrometry, and gross neutron determinations. The isotopic compositions of curium and californium were assumed to be compatible with those calculated from Tables 3 and 4 since no additional feed materials were added after the rework materials were introduced to the main stream process. Plutonium activity in Campaign 69 is expected to be mostly from ^{240}Pu, which is the decayed daughter of ^{244} Cm. This assumption is justified because only HFIR targets (fabricated with curium and americium oxide powders) were used as the feed materials in both Campaigns 68 and 69. For these reasons, chemical separations and mass spectrometry were not used to obtain the isotopic compositions of Pu, Cm, and Cf radionuclides contained in the first sample set. This decision was also made to minimize the analytical cost and the turnaround time for getting the analytical results.

The smear samples were leached individually in a 4N nitric acid solution for 2 hours at room temperature, and a high purity germanium (HPGe) detector was used to obtain the gamma spectrum from an aliquot of the leachate. All of the fission and activation products, as well as ^{241}Am and ^{243}Am, in the smear samples were analyzed by gamma spectrometry. The discrete gamma ray energy peaks were compared with those found in Ref. 10 to identify individual gamma-emitting radionuclides in the sample. These energy peaks were then integrated from the gamma spectrum to quantify the activities associated with these radionuclides. Although the two isotopes of americium (^{241}Am and ^{241}Am) are alpha emitters, they contribute only a small percentage of the total alpha activities. Therefore, their activities can be determined more accurately with gamma spectrometry rather than conventional alpha pulse-height analysis. The gross alpha determinations were made by evaporating an aliquot of the leachate on a stainless steel plate (in duplicate) followed by alpha counting on a gas proportional counter. One of these plates was then counted in an alpha spectrometer to identify the alpha-emitting radionuclides by pulse-height analysis. To quantify the major alpha emitters, each energy peak from the alpha spectrum was integrated to determine the individual peak areas. The individual peak areas were then divided by the total area of all energy peaks to determine the percentage of alpha counts at a particular alpha energy level. The gross alpha and alpha spectrometry analyses thus provided quantitative activities for the different alpha energies. The alpha energy peaks were then compared with those listed in Ref. 11 and 12 to identify the alpha-emitting radionuclides associated with these peaks. Additional information from gross neutron determination (of ^{252}Cf) and gamma ray analysis (for americium isotopes) was used to determine the contributions these nuclides made to their respective alpha energy peaks. As an example, ^{238}Pu and ^{241}Am both have primary alpha energies of nominally 5.5-MeV. By quantifying ^{241}Am through gamma spectrometry, the activity contributed by ^{241}Am to the 5.5-MeV peak was subtracted from the total activity at that energy peak to leave the ^{238}Pu activities. Alpha-emitting radionuclides that were not registered by alpha spectrometry were stated to be less than 1% of the total alpha activity. The selection of this detection limit was based on the sensitivity of the alpha spectrometer used for the analysis. Radioactivity for the "nondetect" gamma-emitting radionuclides is set at the actual < value (i.e., without the < sign) since this is the Miminum Detection Activity (MDA) for these radionuclides.

Because of the large number of nondetect values for ^{238}Pu in the first set of sample data, in addition to the same analyses obtained for the first set, a plutonium separation was performed on the second set of samples to obtain the isotopic activities of ^{238}Pu, $^{239/240}$Pu, and ^{242}Pu. The plutonium was

removed from an aliquot of leachate by solvent extraction and then analyzed through a separate gross alpha and alpha spectrometry determination as described previously. As a result, plutonium isotopes of interest were separated from the other alpha emitters so that the limits of detection were reduced by at least an order of magnitude. Leach and smear samples taken from the same glass and metal waste items were also included in the second data set to study the efficiency of the sampling techniques. Appendix A provides summary analytical results obtained from the two sets of data.[13]

3.3 ASSAY DATA OF MELTED POLYETHYLENE WASTE BUCKETS 2527 AND 6120

As described in Sect. 2.2, polyethylene bottles and plastic waste items from REDC hot cells are normally melted in a gallon paint can for waste volume reduction purposes. This melting polyethylene practice also provides an excellent means of getting a homogeneous waste texture in a waste container. For this reason, two of the melted polyethylene waste buckets (2527 and 6120) were selected for estimating their TRU activity content. The GASP system available at the Waste Examination and Assay Facility (WEAF) was used to obtain the activity of the easy-to-measure gamma radionuclides. A furnace was then used to reduce the bucket content for radiochemical analysis and to verify the NDA measurements. Excessive count rates from non-TRU isotopes "mask" the measurement of emissions from the TRU isotopes. Therefore, it was necessary to keep the contact dose rate on the order of 50 mrem/h for neutron radiation and 50 mrem/h for gamma radiation to prevent high count rates from interfering with the measurement.

Because of a limitation in the design of the GASP system, each waste bucket rested in a "bird cage," which was placed inside a 55 gallon drum. The drum was then transported to the WEAF for measurement. The drum was rotated around a vertical axis during the assay measurements to minimize the radial inhomogeneity effects. Gamma ray attenuation was measured for each segment with a transmission source in the indicated geometry. The energy of this source was selected to match that of the gamma ray line(s) being measured from the drum. The assay results from this technique include a list of the easy-to-measure gamma-emitting isotopes and their concentrations in the waste container. Table 9 provides the GASP results obtained for the two melted polyethylene waste buckets 2527 and 6120.

Table 9. GASP data for REDC melted polyethylene buckets 2527 and 6120

Radionuclides	Bucket 2527 (μCi)	Bucket 6120 (μCi)
Ru-106	1,239.43 ± 27.704	429.158 ± 14.156
Ag-110m	23.638 ± 1.278	5.643 ± 0.735
Sb-125	407.509 ± 11.156	619.289 ± 26.981
Cs-134	129.185 ± 3.621	18.397 ± 1.434
Eu-154	82.139 ± 3.292	453.436 ± 14.933
Cs-137	303.666 ± 6.000	283.658 ± 6.587

After NDA measurements were taken, each of these waste buckets was transported to the radiochemical laboratory for ashing. The ash obtained from these buckets was dissolved in nitric acid and was analyzed using gross alpha, alpha spectrometry, gamma spectrometry, and gross neutron determination methods. Analytical results for bucket 2527 were not available since the ash was accidentally spilled in the drain. The radiological content of bucket 6120 is provided in Table 10. The activities of ^{110m}Ag, ^{134}Cs and ^{137}Cs were relatively low compared to the NDA measurements. Hence, these radionuclides may have vaporized to a large extent and become lost to the exhaust system. The amount of activity that was vaporized because of the high-temperature ashing process could be quantified by the radiochemical sampling results of the air filter installed for the exhaust system. However, this type of data was not collected and analyzed since the ashing experiment could not be totally isolated from other on-going projects at the analytical laboratory in Building 2026.

Table 10. Radiochemical data for melted polyethylene bucket 6120

Analysis	Concentration (Bq/g) Result		Error
Gross alpha	1.0E+06	±	1.3E+04
Alpha emitters			
Cm-244	9.6E+05	±	9.6E+04
Pu-238	3.4E+03	±	6.9E+02
Pu-239/240	4.0E+03	±	8.0E+02
Pu-242	6.0E+01	±	1.2E+01
Am-241	1.1E+04	±	2.4E+01
Am-243	3.1E+02	±	5.4E+00
Cf-252	3.9E+03	±	7.8E+02
Cm-242	1.8E+04	±	3.6E+03
Cm-246	< 1.0E+04		
Beta/gamma emitters			
Co-60	2.5E+01	±	2.6E+00
Ru-106	5.0E+02	±	5.7E+01
Ag-110m	< 9.7E+00		
Sb-125	1.9E+02	±	1.1E+01
Cs-134	7.5E+01	±	3.4E+00
Cs-137	7.9E+02	±	9.3E+00
Ce-144	1.2E+03	±	2.6E+01
Eu-152	1.4E+02	±	3.0E+01
Eu-154	3.9E+03	±	1.3E+01
Eu-155	5.3E+03	±	1.0E+02
Np-239	6.4E+02	±	6.0E+01

Total weight of the ashing materials = 2,143.25 g

Total alpha concentration = 2.70E+04 nCi/g

TRU concentration = 507 nCi/g

4. METHOD OF CHARACTERIZATION

4.1 GENERAL DESCRIPTION OF METHOD

Existing neutron interrogation techniques employed by NDA instruments such as the passive active neutron (PAN) and active passive neutron examination and assay (APNEA) systems cannot distinguish TRU radionuclides (^{238}Pu, $^{239/240}$Pu, ^{242}Pu, ^{241}Am, ^{243}Am, and ^{246}Cm) present in REDC wastes because of interference caused by neutron emissions received from non-TRU radionuclides such as ^{242}Cm, ^{244}Cm, and ^{252}Cf. On the other hand, gamma spectroscopy provides a convenient and accurate method for determining the radioactivity of selective gamma-emitting radionuclides in an REDC waste container. Radionuclides that emit relatively high-energy photons and that have acceptable branching ratios are good candidates for this type of measurement, and they can be "easily measured" from the GASP system currently located at the WEAF. The following six easy-to-measure gamma-emitting radionuclides were used for this study: ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{134}Cs, ^{154}Eu, and ^{137}Cs. Once the activity for these radionuclides is obtained from the GASP system, the TRU activity of a waste container can be determined by multiplying the measured gamma activity, A(g), by the applicable alpha to easy-to-measure gamma activity ratios, X (a,g). To evaluate the use of this method, the activities of nine alpha-emitting radionuclides (^{244}Cm, ^{238}Pu, $^{239/240}$Pu, ^{242}Pu, ^{241}Am, ^{243}Am, ^{252}Cf, ^{242}Cm, and ^{246}Cm) were estimated for REDC waste bucket 6120. The probability of the TRU activity contents being above or below 100 nCi/g was also calculated to establish the appropriate waste classification for this bucket. Radiochemical data obtained from 54 smear and leached samples taken directly from cubicle 9 were used to estimate 54 sets of the alpha to easy-to-measure gamma activity ratios. The GASP system was used to obtain NDA measurements of the six easy-to-measure gamma radionuclides in REDC waste bucket 6120. Statistical analysis will be used to combine radiochemical data with NDA measurements obtained for this waste bucket.

4.2 THE USE OF CUMULATIVE DISTRIBUTION FUNCTION (CDF) PLOTS OF ALPHA TO EASY-TO-MEASURE GAMMA ACTIVITY RATIOS

In general, percentiles are normally used in statistical analysis to evaluate the position of one observation in relation to all of the observations in a data set. Percentile measurements are particularly useful in the environmental compliance area, where decisions must be made for whether or not an environmental pollution level would exceed a specified regulatory limit. Let X_1(a,g), X_2(a,g), . . . , and X_m(a,g) represent the activity ratios of alpha-emitting radionuclide (a) and the easy-to-measure gamma-emitting radionuclide (g) in the pilot study, where m is the total number of samples collected directly from the waste stream. If we arrange all the data points in each of the activity ratio data sets in increasing order, the pth percentile is the data value that is greater than or equal to p% of the values in the set. The X_p(a,g) value at the pth percentile is also less than or equal to (1-p)% of the data values in the same data set. Based on this definition, the value at the 50th percentile, $X_{0.50}$ (a,g), is also called the sample median because at the 50th percentile, half of the data set has individual values greater than $X_{0.50}$ (a,g), and the other half of the data set has values less than $X_{0.50}$ (a,g). Also, other important parameters to be considered for evaluating environmental data are the 90th, 95th, and 99th, percentiles where a decision maker would like to make sure that 90, 95, or 99% of the contamination levels are below a fixed risk or contamination level.

To compute the pth percentile, the activity ratio values in each sample set are arranged from the smallest to the largest [i.e., $X_{i=1}$ (a,g) < $X_{i=2}$ (a,g), . . . ,< $X_{i=m}$ (a,g)]. Then the probability, p_i , that a variable X_p (a,g) is equal to X_i (a,g) is calculated as

$$Pi = \frac{100(i-0.5)}{m} \quad \textbf{(1)}$$

where "i" is the location of an individual sample taken from the ordered data set. A CDF plot can be created by plotting X_i (a,g) against p_i on log-probability paper, where p_i values are rescaled from 0 to 1[14]. Regardless of the type of distribution used, the activity ratio at a certain p^{th} percentile, X_p (a,g) can be obtained directly from this plot. If the plotted points fall approximately on a straight line, then the random variable X_i (a,g) is lognormally distributed. Thus, the geometric mean and the geometric standard deviation of the lognormal distribution for the data set can be directly observed from this CDF plot.

The statistical methods evaluated for this study provide lower-bound and best estimates for the TRU activities of a certain waste container based on both nonparametric and parametric methods. Specifically, the following parameters are obtained with the nonparametric approach:

1. the 50th percentile alpha/gamma activity ratios;
2. the lower-bound (of 95% confidence interval) estimates from the 50th percentile alpha/gamma activity ratios; and,
3. the 5th percentile alpha/gamma activity ratios by visual interpolation of the CDF plots.

Likewise, for the parametric (or lognormal distribution) method, the following parameters are calculated:

1. the geometric mean GM (Y) alpha/gamma activity ratios;
2. the lower bound (of 95% confidence interval) estimates from the GM alpha/gamma activity ratios; and,
3. the 5th percentile alpha/gamma activity ratio.

4.2.1 Nonparametric Method

A nonparametric (or distribution-free) method is used when the underlying distribution of a certain data set is either unknown or unspecified. For this report, a nonparametric method is used to estimate the TRU activity of a waste container because the activity ratio CDFs may not be easily proven to be lognormal to a critical analyst. If one assumes that the CDFs are not properly described by any parametric distribution, the TRU activity based on the 50th percentile value is a reasonable estimator for the median activity ratio in a data set. Another alternative for the decision making relative to the waste classification of a given waste container is to use the 5th percentile as the estimator of the activity ratio.

As mentioned previously, the activity ratios at the 5th and the 50th percentile, $X_{0.05}$(a,g), and $X_{0.50}$(a,g), can be obtained directly from the CDF plot. One can also approximate the (α) percent confidence intervals for any percentile of a data set by using the following expression[15], with the notation $\lfloor\ \rfloor$ and $\lceil\ \rceil$ indicating that we round the i and k entries down and up, respectively, to the nearest whole number:

$$i = \lfloor\ mp - c[mp\ (1-p)]^{1/2}\ \rfloor \tag{2}$$

$$k = \lceil\ mp + c[mp\ (1-p)]^{1/2}\ \rceil \tag{3}$$

where
- i,k = order numbers (ranks) defining the upper and lower bounds of the uncertainty interval associated with the pth percentile,
- m = the total number of samples,
- p = percentile, which may be approximated by Eq. (1),
- c = corresponding deviation such that Prob [$-c < X_p < c$] = α. For α = 95% confidence level, c = 2.

As an example, we collected 54 samples from waste items located in cubicle 9 of the REDC shielded cell banks. Therefore, we have 54 sets of $^{252}Cf/^{106}Ru$ activity ratios. We would like to determine the lower bound of the 95% confidence interval for the 50th percentile of the $^{252}Cf/^{106}Ru$ activity ratio. From this example, m = 54, p = 0.50, and c = 2. Using Eq. (2), the value i is equal to 19. Hence, the lower bound of the 95% confidence interval for the median $^{252}Cf/^{106}Ru$ activity ratio is located at the 19th rank. The TRU activity of a waste container calculated at the pth percentile, A_P (a,g), based on a certain set of activity ratios can be obtained by

$$A_P\ (a,g) = [\ X_P\ (a,g)\ ]\ *\ [\ A\ (g)]\ . \tag{4}$$

As a result, we will have six TRU activities calculated for an individual waste bucket. Additional calculations are required to combine these activities into a single TRU activity estimate for each waste bucket. A discussion of these techniques is provided in Sect. 4.3.4.

4.2.2 Parametric Method

The lognormal distribution can be used to characterize a data set when the logarithm of all observations contained in the data set can be characterized by a normal distribution function. That is, if the activity ratio X_p (a,g) is lognormally distributed, Λ (μ,σ), then the log activity ratios Y_p (a,g) = Ln [X_p (a,g)] will exhibit a normal distribution function, N (μ_Y , σ_Y). The lognormal density function is given by

$$f\ (\ X\ ) = \frac{1}{X\sigma_Y\ \sqrt{2\pi}}\ \exp\ [-\ \frac{1}{2\sigma_Y^2}\ (\ \ln X - \mu_Y\ )^2\ ]\ ,$$

$$\textit{where} \quad X > 0, \quad -\infty < \mu_Y < \infty \quad , \quad \sigma_Y > 0.$$

The values of μ_Y and σ_Y^2 are called the true mean and variance, respectively, of the transformed variable Y(a,g) = Ln [X (a,g)]. Based on p. 169 of R. O. Gilbert[14], μ_Y and σ_Y^2 can be estimated using the following equations:

$$\mu_Y = \ln [X_{0.50}(a,g)]$$

$$\sigma_Y^2 = \left\{ \ln \left[\frac{1}{2} \left(\frac{X_{0.50}(a,g)}{X_{0.16}(a,g)} + \frac{X_{0.84}(a,g)}{X_{0.50}(a,g)} \right) \right] \right\}^2$$

The activity ratios at the 16th, 50th, and 84th percentiles are read from the CDF plot. The mean (μ) and standard deviation (σ) of the untransformed (lognormal) activity ratios Y_p (a,g) distributed from a lognormal distribution can be calculated by:

$$\mu = \exp\left(\mu_Y + \frac{\sigma_Y^2}{2} \right)$$

and

$$\sigma = \mu \, [\exp(\sigma_Y^2) - 1]^{1/2}$$

A simple method for estimating the mean (μ) and variance (σ^2) of an individual activity ratios set, Y_p (a,g), distributed according to a lognormal distribution is to replace μ_Y and σ_Y^2 by $\bar{Y}$ and s_Y^2 as follows:

$$\hat{\mu} = \exp\left(\bar{Y} + \frac{s_Y^2}{2} \right) \qquad (5)$$

$$\hat{\sigma} = \hat{\mu} \, [\exp(s_Y^2) - 1]^{1/2}$$

From p. 167 of Ref. 14, the variance of $\hat{\mu}$ may be approximated by the following equation:

$$s^2(\hat{\mu}) = \exp\left(2\bar{Y} + \frac{s_Y^2}{m} \right) \left[\left(1 - \frac{2s_Y^2}{m} \right)^{-(1-m)/2} * \exp\left(\frac{s_Y^2}{m} \right) - \left(1 - \frac{s_Y^2}{m} \right)^{-(m-1)} \right]$$

Where $$\bar{Y} = \frac{1}{m} \left| \sum_{p=1}^{m} Y_p(a,g) \right| = \frac{1}{m} \left| \sum_{p=1}^{m} \ln X_p(a,g) \right|$$

$$s_Y^2 = \frac{1}{m-1} \sum_{p=1}^{m} [\, Y_p(a,g) - \bar{Y} \,]^2$$

As shown on p. 167 of Ref. 14, the expected value of $\hat{\mu}$ is

$$E[\hat{\mu}] = \mu \left(1 - \frac{\sigma_Y^2}{m}\right)^{-(m-1)/2} \exp\left(-\frac{m-1}{2m}\sigma_Y^2\right)$$
$$= (\textit{true mean})\ (\textit{bias factor})$$

Based on this relationship, $\hat{\mu}$ is a biased estimator for μ, and this bias factor will approach one as the sample number m becomes large. Therefore, Eq. (5) should not be used to estimate the true mean activity ratio of any individual activity ratios set, Y_p (a,g), with a sample number smaller than 100.

The sample geometric mean of Y_p (a,g) can be calculated as GM (Y) = (Y). Because of the skewness characteristics of a lognormal distribution, the estimated values of the geometric mean GM (Y) and the true median activity ratios (i.e., Y_p (a,g) at the 50th percentile) differ by a bias factor, which also depends on the number of samples used to approximate the mean and the variance.[14] In particular,

$$E\ (GM) = E\ [\ \exp\ (\ \bar{Y}\ )\ ] = \exp\ (\mu_Y\ )\ \ \exp\ (\sigma_Y^2\ /\ 2m) \tag{6}$$
$$= (\textit{true median})\ \ (\textit{bias factor}).$$

where

E (GM)	=	estimated value of the geometric mean,
μ_Y	=	natural logarithm of random variable X_p(a,g) at the 50th percentile,
σ_Y^2	=	variance of the transformed (lognormal) activity ratio Y_p (a,g),
m	=	number of random elements in the set.

Note that as the number of random samples increases, the bias factor decreases. This bias factor will also approach one as m becomes large. For the nonparametric analysis no bias is assumed, and the 50th percentile is used as the estimator. If the activity ratio data follow a lognormal distribution as we assumed for the parametric method, then the sample geometric mean should be used as the estimator for the true median activity ratio of each data set. These activity ratios will then be used to estimate the median TRU activity content of a single waste "bucket."

On average, the expected geometric mean value of the activity ratios, as shown in Eq. (6), should be used as the estimator to predict the median activity of TRU isotopes for classification of a particular waste bucket or a 55 gallon drum as TRU or not TRU. However, introducing the bias correction, $\exp(\sigma_Y^2\ /\ 2m)$, to Eq. 6 may overpredict the activity in this type of waste container generated at REDC because of the relatively large variance associated with the activity ratios. This problem can be resolved by collecting additional samples to improve the precision of the activity ratio calculations. The variability of activity ratios also depends on the amount of mass associated with the type of sample collected. As the sample mass increases, the fluctuation of activity measured for each sample will be reduced. Therefore, a different type of sample collection technique could also be employed to minimize the variance associated with each set of activity ratios derived for estimating the TRU activity content of a single waste container.

The Central Limit Theorem implies that the distribution of the mean activity ratios calculated for repetitive, pilot-study-type experiments should be normal regardless of the underlying distributions. This theory would be valid only if all sample observations collected for these experiments came from the same population. That is, if the pilot study were repeated n times, the sample population containing all average activity ratios calculated for each set of experiments would be normally distributed. The activity ratio calculated from individual waste items stored in cubicle 9 is expected to be similar to those items being packed in a 55 gallon waste drum since REDC hot cell wastes are commingled in cubicle 9 before repackaging. Furthermore, repackaging wastes into small waste containers also promotes further cross-contamination within a waste container. Based on this observation, the geometric mean GM(Y) of the activity ratios calculated for (a) each of the smear sample data sets, (b) a large population of REDC waste buckets, and (c) a large number of 55 gallon REDC waste drums should be the same since the average activity ratio calculated for these samples comes from the same normally distributed waste sample population. As a result, the bias factor is removed from Eq. (6). The geometric mean, GM (Y), and the geometric standard deviation, GSD (Y), are used as the estimator for calculating the true median activity ratio of a population of REDC waste buckets or drums:

$$GM\ (Y) = \exp\ (\bar{Y}) = \frac{1}{m} \sum_{i=1}^{m} \ln\ [\ X_p\ (a,g)\ ]\ , \tag{7}$$

$$GSD\ (Y) = \exp\ [\ s_Y\ ]\ ,$$

$$where \qquad s_Y^2 = \left(\frac{1}{m-1}\right) \sum_{i=1}^{m} \left\{ \ln \left[\ X_p\ (a,g) \right] - \bar{Y} \right\}^2 .$$

Similar to the nonparametric method, we will generate six sets of activity ratios to be used for estimating the total TRU activity content of a single waste bucket. Appropriate statistical techniques must be used to consolidate these data sets to come up with a single TRU concentration for a certain waste bucket. These techniques must be evaluated on a case-by-case basis since the calculated activity ratios vary as a function of (a) the correlations between individual alpha-emitting radionuclides and those easy-to-measure gamma-emitting radionuclides and (b) the precision and accuracy of GASP system measurements for one type of radionuclide against another, where measurement uncertainty is the primary contributor. Sect. 4.3.4 will provide an illustration of how this method is used to estimate the TRU activity content for a specific REDC waste bucket.

A large bias factor is associated with the estimated mean activity ratios because of the small sample number associated with each data set. Therefore, $\hat{\mu}$ should not be used to estimate the true mean activity of a waste bucket. However, the estimated mean activity and the lower bound activity of the 95% confidence from this estimated mean value are provided in this report for comparison with the geometric mean activity for illustration purposes. Alpha activities based on the estimated mean activity ratio are calculated as:

$$A_{\hat{\mu}}(a,g) = \hat{\mu} * [\ A\ (g)]\ .$$

Based on the Central Limit Theorem, the distribution of the mean activity will follow the normal distribution function. Therefore, the lower bound activity, A_i (a,g), of the 95% confidence interval of the estimated mean activity, $A_{\hat{\mu}}(a,g)$, should lie about two standard deviations from the estimated mean value:

$$A_i(a,g) = A_{\hat{\mu}}(a,g) - [2 * \sigma_A(a,g)]. \tag{8}$$

The standard deviation, σ_A (a,g), of the estimated mean activity is estimated based on the error associated with independent variable gamma activities, A(g), and the estimated mean activity ratio, $\hat{\mu}$. Let P = X * Y, with X and Y being two independent random variables taken from two different populations (μ_X, σ_X) and (μ_Y, σ_Y), respectively. Then

$$\begin{aligned}
\sigma^2(XY) &= E(XY)^2 - E^2(XY) = [E(X^2) * E(Y^2)] - [E^2(X) * E^2(Y)], \\
\sigma^2(XY) &= [\sigma^2(X) + E^2(X)] * [\sigma^2(Y) + E^2(Y)] - [E^2(X) * E^2(Y)], \\
&= [\sigma^2(X) * \sigma^2(Y)] + [E^2(X) * \sigma^2(Y)] + [E^2(Y) * \sigma^2(X)], \\
&= [\sigma^2(X) * \sigma^2(Y)] + [\mu^2(X) * \sigma^2(Y)] + [\mu^2(Y) * \sigma^2(X)], \\
\text{or} \quad \sigma^2(P) &= [\sigma^2(X) * \sigma^2(Y)] + [\mu^2(X) * \sigma^2(Y)] + [\mu^2(Y) * \sigma^2(X)].
\end{aligned}$$

The following substitutions are made to estimate the variance from the estimated mean TRU activities of a waste bucket:

$$\begin{aligned}
P &= A_{\hat{\mu}}(a,g), \\
X &= A(g), \text{ and} \\
Y &= Y_p(a,g) = \hat{\mu}.
\end{aligned} \tag{9}$$

The standard deviation of the set containing all average activity ratios, as shown in Eq. 9, is derived from Ref. 16, where m is equal to the number of samples collected for each of the average activity ratios. The variance associated with the estimated mean activity, $A_{\hat{\mu}}(a,g)$, can be calculated as:

$$s_A^2(a,g) = [s^2(g) * s^2(\hat{\mu}) / m] + [A^2(g) * s^2(\hat{\mu}) / m] + [\hat{\mu} * s^2(g)].$$

Another alternative for decision making relative to classification of a given waste drum is to use the 5th percentile of the activity ratio distributions as the estimator. For the parametric analysis, by definition:

$$P[(\mu_Y - 2 * s(\hat{\mu})/\sqrt{m}) < Y < (\mu_Y + 2 * s(\hat{\mu})/\sqrt{m})] \cong 0.95.$$

$$P[\exp(\mu_Y - 2 * s(\hat{\mu})/\sqrt{m}) < \exp(Y) < \exp(\mu_Y + 2 * s(\hat{\mu})/\sqrt{m})] \cong 0.95.$$

$$P[\exp(\mu_Y) * \exp(-2 * s(\hat{\mu})/\sqrt{m}) < \exp(Y) < [\exp(\mu_Y) * \exp(2 * s(\hat{\mu})/\sqrt{m})] \cong 0.95.$$

As a result, the lower-bound activity ratio of the 95% confidence interval of the geometric mean (or the activity ratio at the 5th percentile) is:

$$X_{0.05}\ (a,g)\ =\ \exp\ (\ \mu_Y\ )\ *\ \exp\ (-2 * s\,(\hat{\mu})/\sqrt{m}\ )\ . \tag{10}$$

The corresponding (lower bound at the 95% confidence interval) TRU activity of a waste bucket can be calculated as:

$$A_{0.05}\ (a,g) = A(g)\ *\ X_{0.05}\ (a,g)\ . \tag{11}$$

4.3 ESTIMATING TRU ACTIVITY FOR AN REDC WASTE CONTAINER

It is apparent that the activity ratio for any given REDC bucket of radioactive waste is not known; however, statistical characteristics of these ratios can be readily derived from the radiochemical analyses of selected waste samples stored in REDC cubicle 9. The radiochemical results can then be used in conjunction with NDA data collected for an individual waste bucket to effectively estimate the TRU activities of isotopes that cannot be easily measured. There are three major assumptions used to develop the characterization methods employed in this report. Discussion regarding the validity of these assumptions is provided in Sects. 4.3.1 through 4.3.3.

4.3.1 Uncertainty Associated with Sampling and Measurement Techniques

Sampling uncertainties derive from the following factors: (1) the amount of activity deposited on an individual waste item per unit area, (2) the transfer of materials from the surface of a waste item to a Q-tip during the sampling process, (3) moisture on the surface sampled, and (4), the type of waste item surface. Contamination of materials on contact often occurs nonuniformly. For example, protective clothing and tools are generally contaminated at points of contact. This type of contamination would result in a nonuniform deposition of activity onto a new surface. On the other hand, the deposition of contaminated particles onto surfaces from contaminated air would be generally uniform.

Transfer of material from a contaminated surface to a Q-tip used for sampling depends on the chemical form of the contamination, the amount of moisture in the Q-tip, the pressure applied between the Q-tip and surface, and the rotation of the tip during sampling. Moisture on a surface would generally facilitate the transfer of a nonfixed contamination from a smooth surface to the Q-tip. This may not be the case for rough surfaces that may also retain some of the contaminated Q-tip materials.

Measurement uncertainties involve sample preparation, calibration, type of radiation, equipment, and counting time. The Q-tip may be leached or dissolved in preparation for alpha spectroscopy, and leachate may be subjected to additional chemical steps for separation of some radionuclides. Less sample preparation is generally needed for gamma spectroscopy than for alpha spectroscopy; however, the measurement uncertainties associated with equipment calibrations for each analytical method are comparable. If several isotopes are measured simultaneously during either alpha or gamma spectroscopy, the number of counts obtained from one nuclide may be very high and may be below the minimum detectable activity (MDA) for another. The uncertainties associated with these extreme

measurements are caused by the limiting operating conditions of individual instrumentation used to obtain analytical data.

To obtain an estimate of one isotope relative to another from the pilot study data, two reasonable approaches are considered. The first approach is to add all alpha activities for the TRU radionuclides (i. e., the numerator) and divide this value by individual easy-to-measure gamma emitters (i.e., the denominator). The second option would be to use individual (TRU) alpha to easy-to-measure gamma activity ratios. Reference 13 provides detailed discussion of the applicability of using the first option for classifying TRU wastes. Based on our evaluations of the sampling process, the uncertainties associated with collecting samples dominate the measurement uncertainties; therefore, they need to be eliminated from the TRU activity estimation. For this reason, the second option is used in this report. Another important consideration is that samples with high alpha activities dominate the activity ratio value if the first option is used. As a result, important statistical information relative to the dispersion of a data set would be discarded if sampling uncertainties were more important than measurement uncertainties. For the case where measurements are reported as less than MDA, measurement uncertainties may exceed sampling uncertainties. In order to compensate for the measurement uncertainties, activities measured for the "nondetect" (i.e., below the MDA level) alpha-emitting radionuclides are set at 1% of the gross alpha activity. The selection of this detection level was based on the sensitivity of the alpha spectrometer used for the analysis. The MDA assigned to individual easy-to-measure gamma-emitting radionuclides is set at the instrument detection limit.

4.3.2 Relative Mass Associated with Smear/Leach Samples and by Waste Containers

Activity ratios, X (a,g), associated with a single smear sample generally represent very little mass. Therefore, the large variance in the activity ratios calculated for a set of "m" smear samples may be created as a result of the measurement inconsistency. Very small or large activity ratios can also be obtained when one of the radionuclides is found in low concentration. Only a single set of activity ratios, R_p (a,g), exists if all of the REDC hot cell wastes can be homogenized into a single container. If a large number of smear samples were obtained from the waste items stored in cubicle 9, the arithmetic mean activity ratio, X_{avg} (a,g), of the smear samples distribution would be equal to the activity ratio, R_p (a,g), calculated for all of REDC wastes. This observation is made based on the assumption that the waste materials collected from cubicle 9 are representative of the entire RH-TRU REDC waste stream. This assumption is reasonable since the contents of the REDC waste containers are arbitrary selected from the same waste items stored in cubicle 9. Based on this assumption, the geometric mean activity ratios set, X_{avg} (a,g), obtained from the pilot study samples can then be used to estimate the geometric mean activity of alpha-emitting radionuclides present in the "bucket" of REDC wastes.

As the mass of individual samples increases, the variability of activity ratios will decrease. As a result, activity ratios associated with the 3 gallon buckets should vary considerably less than those associated with very small mass samples. Likewise, the variability of activity ratios associated with the 55 gallon drums should be much less than those associated with the REDC waste buckets. Based on this analogy, the geometric mean of the activity ratios obtained from samples taken for the pilot study can be used to predict the geometric mean alpha/gamma activity ratios sampled from the REDC waste drums. If the activity of gamma-emitting radionuclides in a 55 gallon drum can be measured using the GASP system, we can then use the same technique used on the 3 gallon waste bucket to estimate the TRU activity content of a waste drum.

4.3.3 Correlation Between Alpha and Easy-to-Measure Gamma-Emitting Radionuclides

If a relationship between the activity of alpha radionuclides (A_α) and the activity of gamma radionuclides (A_γ), can be described as:

$$\frac{A_\alpha}{A_\gamma^{k_1}} = const. = k,$$

then linear correlation can be establish between the log of alpha-emitting activities and gamma-emitting radionuclides:

$$\ln A_\alpha = \ln k + k_1 \ln A_\gamma. \qquad (12)$$

Ln (k) and k_1 are the intercept and the slope, respectively, of a linear regression line for a plot of ln A_α vs ln A_γ. Using this relationship, one can estimate A_α from A_γ values (measured by the GASP) if k and k_1 values can be predetermined from the REDC pilot study data sets. The same approach was used to correlate the gross alpha activity with the total TRU activity obtained from the pilot study results[12]. Several scatter plots of easy-to-measure gamma-emitting and alpha-emitting radioisotopes are shown in Appendix B. Note that a definite trend is apparent in most of the plots. For example, linear correlation can be established between the log of ^{241}Am, ^{243}Am, or ^{246}Cm activities vs those calculated for ^{137}Cs. However, several of the other plots in Appendix B also show poor correlations, where high percentages of the alpha activity measurements were below the detection limits. The plots of ^{242}Cm vs ^{125}Sb or ^{242}Pu vs ^{134}Cs show no correlation between the alpha- and gamma-emitting radionuclides since random scattering of data points is found in these plots.

4.3.4 TRU Activity Estimation Techniques

Using six easy-to-measure gamma activities, measured by the GASP, to estimate the total TRU content of an REDC waste bucket will result in having six different values of TRU activities associated with this waste bucket. As a result, appropriate statistical techniques must be developed to combine these activities into a single total TRU activity value. A weighting factor associated with individual activity ratios can be used to determine the total TRU activity content in a waste bucket if the sampling measurement uncertainty can be shown to be statistically significant in comparison to the sampling uncertainty. One method is to adjust the TRU activity in a bucket based on the coefficient of variation. Specifically, the weighting factors can be calculated as follows:

$$w\ (a,g) = \frac{1\ /\ [cv^2(a,g)]}{\sum_{g=1}^{6} 1\ /\ [cv^2(a,g)]},$$

where $cv^2(a,g)$ = coefficient of variation of the alpha activities based on activity ratio $\hat{\mu}$,
$= [\sigma_A\ (a,g)\ /\ A_{\hat{\mu}}(a,g)]^2$.

The total TRU activity can be determined as:

$$A_{TRU} = \sum_{a=1}^{6} \frac{1}{6} \sum_{g=1}^{6} [w(a,g) * A_{\hat{\mu}}(a,g)].$$

If the correlations between individual alpha- and gamma-emitting radionuclides cannot be established, the activity values derived from each of the six activity ratios must be carefully examined and adjusted based on how well these TRU activities are in agreement with each other. Section 5.0 shows how we combine the six TRU activity values derived from the six gamma activities (measured by the GASP system) to estimate the total TRU content of REDC waste bucket 6120. Note that the activity ratios from the CDFs can be used to establish probability that the alpha activity is less than or greater than a given value. Therefore, the TRU concentration in a waste container can be estimated within a certain confidence limit if the mass of the waste is known.

5. CASE STUDY

As an illustration of the characterization methods described in Sect. 4, this section provides detailed discussions on how to use the NDA data collected from REDC waste bucket 6120 in conjunction with the pilot study data to determine if this bucket can be classified as TRU waste. In addition, the TRU content of this bucket will be estimated using the NDA/DA data fusing techniques described in Sect. 4.3.4.

Based on analytical data presented in Appendix A, the TRU (alpha-emitting) radionuclides present in samples collected for the REDC pilot study include ^{246}Cm, ^{238}Pu, $^{239/240}$Pu, ^{242}Pu, ^{241}Am, and ^{243}Am. Other alpha-emitting radionuclides are ^{244}Cm, ^{242}Cm, and ^{252}Cf. As defined in the previous section, the easy-to-measure gamma-emitting radionuclides include ^{106}Ru, ^{110m}Ag, ^{125}Sb, ^{134}Cs, ^{154}Eu, and ^{137}Cs. Activities of the easy-to-measure gamma-emitting radionuclides are collected using the GASP. Because of the limited GASP capability, NDA data were collected from a 3 gallon waste bucket instead of the actual nine buckets in a 55 gallon drum.

5.1 CDF PLOTS GENERATED FROM THE PILOT STUDY DATA

For this study, 54 activity ratios were generated for each of the alpha-emitting radionuclides to the easy-to-measure gamma-emitting radionuclides. These activity ratios, X(a,g), and their respective cumulative probability, calculated by Eq. 1, are provided in Appendix C. The CDFs generated for these activity ratios are plotted on a probability scale and are provided in Appendix D. This form of the data presentation permits one to obtain direct visual information about the data. As an example, the CDF plots allow us to graphically identify the 50th percentile, geometric mean, and geometric standard deviation of the distribution for each activity ratio data set. The activity ratios taken directly from the CDF plots at various percentiles are provided in Appendix E. These values are obtained to calculate the estimated mean and geometric mean of these activity ratios. Nearly all of the CDF plots presented in Appendix D are linear between the 10th percentile and the 90th percentile, which indicates that the activity ratios $X_p(a, g)$ are lognormally distributed, with the exception of the upper and lower tails regions. Irregularity in some of the CDF plots may be caused by combining data from various sample types, such as glass, polyethylene, and wipes. The divergence from lognormality of the tail regions may be from sampling a very small mass of wastes, the type of chemical isotopes used during a particular campaign, or simply from measurement inaccuracies. On the other hand, to a critical analyst, the distribution of activity ratios may not be lognormal. For this reason, both nonparametric and parametric statistical methods are used to estimate the TRU concentration of REDC waste bucket 6120.

5.2 ESTIMATING TRU ACTIVITY CONTENT IN BUCKET 6120

Tables 11 to 13 provide a summary of the alpha activity contents estimated for REDC waste bucket 6120, using the nonparametric method. Table 11 lists a matrix of activities at the 50th percentile determined from each easy-to-measure radionuclide for all alpha-emitting radionuclides and for the TRU isotopes. Note that the activities predicted from ^{110m}Ag are consistently low and those estimated from ^{125}Sb are consistently high in comparison with those estimated from ^{106}Ru, ^{134}Cs, ^{152}Eu, and ^{137}Cs. The estimated activities at the lower bound 95% confidence interval of the 50th percentile

Table 11. Estimated activity based on the 50th percentile using the nonparametric

Alpha emitters	Unit	Easy-to-measure gamma radionuclides						Average alpha activity
		Ru-106	Ag-110	Sb-125	Cs-134	Eu-154	Cs-137	
Cf252	(µCi)	722.70	204.86	2,919.33	322.71	865.61	300.39	889.27
Cm244	(µCi)	73,761.53	20,681.36	412,859.54	57,368.28	75,572.82	45,127.43	114,228.49
Cm242	(µCi)	614.13	235.66	3,362.12	321.17	765.40	234.30	922.13
Cm246	(µCi)	557.91	163.89	2,993.02	298.46	585.84	261.82	810.16
Pu238	(µCi)	277.67	94.49	928.93	148.55	356.40	132.47	323.08
Pu*	(µCi)	350.19	71.02	1,109.77	151.30	395.85	135.87	369.00
Pu242	(µCi)	25.32	5.46	170.92	277.73	47.61	24.6	91.95
Am241	(µCi)	629.57	220.28	2,659.23	247.06	767.21	260.68	797.34
Am243	(µCi)	38.62	10.54	180.21	17.46	42.62	16.17	50.94
Total activity	(µCi)	76,977.64	21,687.57	427,183.08	59,152.71	79,399.36	46,493.82	118,482.36
TRU activity	(µCi)	1,879.28	565.69	8,042.09	1,140.55	2,195.54	831.69	2,442.47
TRU conc.	(nCi/g)	876.84	263.94	3,752.29	532.16	1,024.40	388.05	1,139.61

Table 12. Estimated activity at the lower-bound 95% confidence interval of the 50th percentile

Alpha emitters	Unit	Easy-to-measure gamma radionuclides						Average alpha activity
		Ru-106	Ag-110	Sb-125	Cs-134	Eu-154	Cs-137	
Cf252	(µCi)	507.19	141.13	2,322.33	243.41	700.76	250.29	694.18
Cm244	(µCi)	46,730.54	5,819.28	175,270.47	17,210.48	42,509.63	15,758.78	50,549.86
Cm242	(µCi)	379.64	38.24	1,393.40	123.78	338.64	119.43	398.86
Cm246	(µCi)	355.03	85.14	2,043.65	183.75	401.91	180.51	541.66
Pu238	(µCi)	156.06	65.56	792.11	86.43	244.16	89.15	238.91
Pu*	(µCi)	218.96	23.11	527.05	44.75	181.37	49.17	174.07
Pu242	(µCi)	8.58	1.93	40.87	3.46	11.08	3.21	11.52
Am241	(µCi)	479.65	143.08	2,041.36	166.01	655.74	160.13	607.66
Am243	(µCi)	28.06	6.50	141.20	13.40	32.39	13.82	39.23
Total activity	(µCi)	48,863.70	6,323.97	184,572.46	18,075.47	45,075.68	16,624.49	53,255.96
TRU activity	(µCi)	1,246.34	325.32	5,586.25	497.79	1,526.65	495.99	1,613.06
TRU conc.	(nCi/g)	581.52	151.79	2,606.44	232.26	712.31	231.42	752.62

Table 13. Estimated activity at the 5th percentile using nonparametric method

Alpha emitters	Unit	Easy-to-measure gamma radionuclides						Average alpha activity
		Ru-106	Ag-110	Sb-125	Cs-134	Eu-154	Cs-137	
Cf252	(μCi)	64.37	9.60	644.06	31.32	199.06	32.05	163.41
Cm244	(μCi)	1,122.25	26.44	3,096.45	107.71	165.96	104.10	770.48
Cm242	(μCi)	17.60	0.74	33.44	1.48	15.87	1.42	11.76
Cm246	(μCi)	17.17	5.46	444.03	39.33	112.00	50.77	111.46
Pu238	(μCi)	11.16	1.17	86.70	11.16	26.75	8.23	24.19
Pu*	(μCi)	11.16	0.79	29.73	4.86	13.15	3.40	10.51
Pu242	(μCi)	0.39	0.11	4.34	69.52	1.54	0.14	12.67
Am241	(μCi)	34.76	5.46	619.29	60.71	298.36	41.98	176.76
Am243	(μCi)	3.86	0.40	33.44	4.12	16.32	3.97	10.35
Total activity	(μCi)	1,282.71	50.18	4,991.47	330.20	849.01	246.07	1,291.61
TRU activity	(μCi)	78.49	13.40	1,217.52	189.69	468.13	108.50	345.96
TRU conc.	(nCi/g)	36.62	6.25	568.07	88.51	218.42	50.62	161.42

50th percentile value are reported in Table 12. The percentile number defining the lower bound of individual activity ratios are determined by Eq. 2. The lower-bound activities are calculated based on Eq. 4. The estimated activities at the 5th percentile, reported in Table 13, are derived from the activity ratios taken directly from visual inspection of the CDF plots provided in Appendix D. The activities calculated in Table 12 are based on the assumption of random sampling from a collection of activity ratio distributions. The activities listed in Table 13 are based on a one-to-one correspondence between the activity ratios measured for bucket 6120 and the collection of samples taken from the pilot study. Activities provided in Table 12 are generally larger than those shown in Table 13 since most of the CDF plots, shown in Appendix D, cannot be linearly fitted from below the 10th percentile and also above the 90th percentile values.

Tables 14 to 18 provide matrix of alpha activities contained in REDC waste bucket 6120 using the parametric method. Tables 14 and 15 list activity estimates based on the lognormal distribution obtained from the estimated mean and geometric mean activity ratios of assay samples taken for the pilot study. Activity data in Tables 11 and 15 are expected to be similar since the log of activity ratios are normally distributed. These activities are lower than those in Table 14 because the bias factor (shown in Eq. 6) is not accounted for when the geometric mean is used as the estimator of the mean. Based on Tables 11 and 15, the estimated geometric mean TRU concentration in bucket 6120 is approximately 1200 nCi/g. The estimated mean TRU concentration value listed in Table 14 is high because of a bias factor estimator of the mean. As discussed previously, this bias factor can be reduced as more samples are taken to improve the accuracy of the activity ratios. Tables 16 and 17 list the TRU activities at the lower bound of the 95% confidence limit from the estimated mean and geometric mean activities, respectively.

Table 14. Estimated mean activity using a lognormal distribution method

Alpha emitters	Unit	Easy-to-measure gamma radionuclides						Average alpha activity
		Ru-106	Ag-110	Sb-125	Cs-134	Eu-154	Cs-137	
Cf252	(µCi)	1,248.86	148.84	4,023.18	566.65	1,113.49	665.45	1,294.41
Cm244	(µCi)	243,767.44	42,404.53	558,932.08	74,940.50	214,583.52	60,441.41	199,178.25
Cm242	(µCi)	1,188.13	129.49	3,713.43	498.81	1,047.59	508.93	1,181.06
Cm246	(µCi)	1,643.10	159.90	3,370.99	673.48	1,665.28	507.60	1,336.73
Pu238	(µCi)	1,019.46	135.75	1,664.82	310.27	0.00	371.55	583.64
Pu*	(µCi)	1,014.73	99.32	1,400.93	243.46	860.27	275.83	649.09
Pu242	(µCi)	10.99	1.66	28.86	5.65	12.63	5.86	10.94
Am241	(µCi)	1,815.76	349.87	4,799.00	706.53	1,184.39	624.13	1,579.95
Am243	(µCi)	67.77	14.57	182.67	25.09	59.05	23.77	62.15
Total activity	(µCi)	251,776.24	43,443.92	578,115.98	77,970.44	220,526.21	63,424.53	205,876.22
TRU activity	(µCi)	5,571.82	761.06	11,447.28	1,964.48	3,781.62	1,808.74	4,222.50
TRU conc.	(nCi/g)	2,599.70	355.10	5,341.09	916.59	1,764.43	843.93	1,970.14

Table 15. Geometric mean activity, GM (Y), based on the log of average activity ratio values

Alpha emitters	Unit	Easy-to-measure gamma radionuclides						Average alpha activity
		Ru-106	Ag-110	Sb-125	Cs-134	Eu-154	Cs-137	
Cf252	(µCi)	624.70	161.20	3,191.53	336.65	821.37	312.89	908.06
Cm244	(µCi)	67,236.66	17,349.75	343,506.04	36,233.73	88,404.14	33,675.98	97,734.38
Cm242	(µCi)	463.36	119.57	2,367.26	249.70	609.23	232.08	673.53
Cm246	(µCi)	558.75	144.18	2,854.61	301.11	734.66	279.85	812.19
Pu238	(µCi)	242.46	62.56	1,238.71	130.66	318.79	121.44	352.44
Pu*	(µCi)	262.74	67.80	1,342.31	141.59	345.45	131.59	381.91
Pu242	(µCi)	37.80	9.75	193.13	20.37	49.70	18.93	54.95
Am241	(µCi)	606.67	156.54	3,099.42	326.93	797.66	303.85	881.85
Am243	(µCi)	34.12	8.80	174.29	18.38	44.86	17.09	49.59
Total activity	(µCi)	70,067.26	18,080.15	357,967.31	37,759.13	92,125.87	35,093.71	101,848.90
TRU activity	(µCi)	1,742.54	449.64	8,902.47	939.05	2,291.13	872.76	2,532.93
TRU conc.	(nCi/g)	813.04	209.80	4,153.73	438.14	1,069.00	407.21	1,181.82

Table 16. Lower-bound activity of 95% confidence interval of the estimated mean activity using lognormal distribution method

Alpha emitters	Unit	Easy-to-measure gamma radionuclides						Average alpha activity
		Ru-106	Ag-110	Sb-125	Cs-134	Eu-154	Cs-137	
Cf252	(µCi)	1,231.50	140.97	3,967.25	358.92	1,103.11	654.44	1,242.70
Cm244	(µCi)	239,754.12	39,257.79	550,546.76	47,459.18	212,221.32	59,497.46	191,456.10
Cm242	(µCi)	1,170.51	122.49	3,657.67	315.88	1,037.36	500.31	1,134.04
Cm246	(µCi)	1,443.29	127.75	3,121.86	389.54	1,508.91	460.44	1,175.30
Pu238	(µCi)	995.43	125.46	1,636.15	195.58	0.00	361.60	552.37
Pu*	(µCi)	993.24	93.10	1,379.22	153.70	847.92	270.17	622.89
Pu242	(µCi)	10.68	1.51	28.22	3.52	12.38	5.58	10.32
Am241	(µCi)	1,787.54	326.96	4,730.12	447.39	1,173.28	613.93	1,513.20
Am243	(µCi)	66.83	13.72	180.22	15.90	58.50	23.42	59.77
Total activity	(µCi)	247,453.13	40,209.74	569,247.48	49,339.61	217,962.79	62,387.35	197,766.69
TRU activity	(µCi)	5,297.01	688.50	11,075.81	1,205.63	3,601.00	1,735.15	3,933.85
TRU conc.	(nCi/g)	2,471.48	321.24	5,167.76	562.53	1,680.16	809.59	1,835.46

Table 17. Estimated lower-bound activity of 95% confidence interval from the geometric mean activity, GM (Y)

Alpha emitters	Unit	Easy-to-measure gamma radionuclides						Average alpha activity
		Ru-106	Ag-110	Sb-125	Cs-134	Eu-154	Cs-137	
Cf252	(µCi)	452.44	113.23	2,418.85	245.75	637.59	224.65	682.09
Cm244	(µCi)	43,695.57	6,792.41	143,326.58	14,214.72	37,509.44	12,938.82	43,079.59
Cm242	(µCi)	314.85	58.70	1,261.08	126.39	323.87	116.19	366.85
Cm246	(µCi)	370.58	90.84	2,024.17	220.50	521.93	211.57	573.27
Pu238	(µCi)	147.80	39.26	854.35	85.12	227.88	80.26	239.11
Pu*	(µCi)	170.40	34.74	701.03	71.45	183.24	65.47	204.39
Pu242	(µCi)	16.86	4.63	96.68	9.75	25.99	8.92	27.14
Am241	(µCi)	402.10	99.13	2,331.88	233.80	629.59	219.86	652.73
Am243	(µCi)	24.80	5.89	137.14	14.86	36.77	13.72	38.86
Total activity	(µCi)	45,595.41	7,238.83	153,151.76	15,222.36	40,096.31	13,879.47	45,864.02
TRU activity	(µCi)	1,132.54	274.50	6,145.25	635.49	1,625.40	599.80	1,735.50
TRU conc.	(nCi/g)	528.42	128.07	2,867.26	296.51	758.38	279.86	809.75

Table 18. Estimated activity at the 5th percentile based on the lognormal distribution method and a visual fit to the activity ratio data

Alpha emitters	Unit	Easy-to-measure gamma radionuclides						Average alpha activity
		Ru-106	Ag-110	Sb-125	Cs-134	Eu-154	Cs-137	
Cf252	(μCi)	94.41	8.74	743.15	68.15	217.65	51.06	197.19
Cm244	(μCi)	6,866.53	497.13	6.19	68.15	16,323.70	5,673.16	4,905.81
Cm242	(μCi)	68.67	7.65	297.26	31.24	99.76	24.11	88.11
Cm246	(μCi)	85.83	5.46	402.54	31.24	181.37	39.71	124.36
Pu238	(μCi)	16.74	1.15	123.86	11.07	58.95	7.38	36.52
Pu*	(μCi)	30.04	2.73	235.33	18.46	36.27	19.57	57.07
Pu242	(μCi)	3.43	0.04	340.61	0.21	1.36	0.17	57.64
Am241	(μCi)	5.15	3.55	619.29	53.95	262.99	48.22	165.53
Am243	(μCi)	8.58	0.55	445.89	5.11	13.60	2.13	79.31
Total activity	(μCi)	7,179.38	527.00	3,214.11	287.59	17,195.65	5,865.51	5,711.54
TRU activity	(μCi)	149.78	13.47	2,167.51	120.05	554.55	117.18	520.42
TRU conc.	(nCi/g)	69.88	6.29	1,011.32	56.01	258.74	54.67	242.82

Table 18 lists the alpha activities at the 5th percentile using a visual fit of the activity ratios to the lognormal distribution function. The TRU activities estimated in Tables 13, 17, and 18 are compatible with each other. Based on these activity values, waste bucket 6120 can be classified as TRU since at the 95% confidence level, the calculated activities for this bucket exceeded 100 nCi/g.

As mentioned previously, the TRU activity values derived from ^{110m}Ag are generally low in comparison to the other easy-to-measure gamma emitting radionuclides. On the other hand, TRU activities derived from ^{125}Sb always have the largest values. These results may be caused by the measurement problems associated with the gamma measurements or poor correlations between alpha- and gamma-emitting radionuclides. A series of plots provided in Appendix B shows that there is a general correlation between the alpha and selected gamma activity. However, the linear relationship (as shown in Eq. 12) cannot be easily established for these types of radionuclides. For these reasons, the arithmetic average activity calculated from the six activity sets is used to determine if a waste container can be classified as TRU. The estimated mean alpha activities are also calculated using the weighting factor techniques, as described in Sect. 4.3.4 of this report. These alpha activities are listed in Appendix E along with the estimated activity, $A_{\hat{\mu}}(a,g)$, defined in the equations given on p. 30, for comparison purposes. Additional sample collection, mathematical modeling, and statistical evaluations must be performed to described the relationship between the alpha- and gamma-emitting radionuclides. These activities are necessary to quantify the TRU activity content of a specific waste bucket.

6. CONCLUSIONS AND RECOMMENDATIONS

The objectives of this report are to determine if a waste container generated from ORNL/REDC can be classified as TRU and to provide an appropriate method of estimating the initial TRU concentration in this container. The methodology presented in this report combines gamma spectroscopy measurements of waste packages with radiochemical analyses of smear samples and with statistical analyses to obtain estimates of alpha-emitting radionuclides in waste containers. This approach, with some additional research, is expected to provide an effective and practical technique for characterization of TRU radioactive waste to meet the Waste Isolation Pilot Plant (WIPP) waste acceptance criteria (WAC).

The recommended characterization method was evaluated for its effectiveness using a set of 54 smear samples and waste bucket 6120 taken from the newly generated TRU wastes in cubical nine of the REDC. The TRU activity obtained from the ash of bucket 6120 is reported to be 507 nCi/g with no uncertainty estimate included. Table 19 provides summaries of the total and TRU activities estimated for this bucket based on various statistical methods described in this report. Both nonparametric and parametric methods estimate REDC waste bucket 6120 to be TRU. The nonparametric method predicts that bucket 6120 contains TRU materials since the TRU concentration estimated at the 50th and the 5th percentile exceeded the 100 nCi/g limit. The parametric method determines that the REDC bucket 6120 can be classified as TRU because both the geometric mean TRU activities (to be used as the true median estimator), and the lower bound 95% confidence intervals from the geometric mean TRU concentration also exceeds 100 nCi/g.

Table 19. Activities estimated for bucket 6120 based on nonparametric and parametric statistical methods

Statistical Evaluation Techniques	Total Activity (μCi)	TRU Activity (μCi)	TRU Concentration (nCi/g)
Nonparametric method			
50th percentile activity	118,482.36	2,442.47	1,139.61
5th percentile activity	1,291.61	345.96	161.92
Lower bound of the 50th percentile activity	53,255.96	1,613.06	752.62
Parametric method			
Mean activity	205,876.22	4,222.50	1,970.14
Geometric mean activity	101,848.90	2,532.93	1,181.82
5th percentile activity	5,711.54	520.42	242.82
Lower bound of the mean activity	197,766.69	3,933.85	1,835.46
Lower bound of the geometric mean activity	45,864.02	1,735.50	809.75

The TRU content in bucket 6120 should not be based on the estimated mean (first moment) TRU concentration calculated from the parametric method due to the skewness associated with the TRU activity ratios taken from the CDF plots. The bias correction could be eliminated by obtaining a distribution associated with a larger accumulation of mass. Either the geometric mean TRU concentration or the 95% lower confidence interval of the geometric mean TRU concentration is recommended to be used for determining that a particular REDC waste bucket is or is not TRU. However, the CDF plots can be used more effectively to classify a waste package as TRU or not TRU since the alpha/gamma activity ratio at any percentile can be estimated directly from these CDF plots, regardless of the distribution type of the data. The probability of a concentration to be above or below a given value can be determined directly from the CDF of alpha-to-gamma emitting radionuclides. The correlation between alpha- and gamma-emitting radionuclides is reflected in the slope of the CDFs. Therefore, it may not be prudent to commit a large effort to optimize calibration models.

Based on the 50th percentile and the geometric mean estimates, both parametric and nonparametric methods predict that the TRU concentration for bucket 6120 is approximately 1200 nCi/g. However, there is a large uncertainty associated with this TRU concentration estimate since activities measured in small samples reflect the expectedly large relative dispersion associated with the amount of alpha- and gamma-emitting radionuclides deposited in small surface areas. Analyses of at least five-bucket-sized waste samples will significantly reduce this uncertainty. Activity ratios derived from the radiochemical analyses associated with the five-bucket-sized waste samples should be compared with those activity ratios estimated from the smears samples results collected from the pilot study. This evaluation is necessary to resolve the problem associated with the distribution of radionuclides in small mass samples. Additional mathematical modeling efforts and more statistical evaluations must also be performed to reduce the upper- and lower-bound uncertainty associated with the activity ratio data sets generated from the pilot study.

Additional data are also required to reduce the bias factor and to improve the estimated mean TRU activity calculated for bucket 6120. This additional information could be obtained by ashing more buckets, improving low-energy photon measurements, and quantifying fissile isotope concentrations. To ensure that fewer drums are misclassified by using the estimated activity ratio estimates at the 50th percentile, additional samples should be obtained. This is especially true for situations in which less than 30 samples are available. To improve the 5th percentile criterion, the variance of the activity ratio distribution must be reduced. This large variance is primarily the result of the very small mass represented by the samples relative to masses associated with disposal drums. As an alternative, a different sample collection method, such as a leaching (instead of smearing) technique, should be used to increase the amount of activity per unit mass associated with each sample collected for radiochemical analysis. Leaching of REDC waste samples is also recommended to minimize the number of nondetect values in the analytical reports.

The upper and lower bounds of the activity predictions associated with the smear sample CDFs can be significantly reduced by using only gamma spectroscopy. In particular, isotopic ratios of gamma-emitting radionuclides are available from the smear and leach samples obtained by the pilot study. If one generates CDFs for these radionuclides from the pilot study data, variances in these distributions should be characteristically large as is the case for the alpha to easy-to-measure gamma-emitting radionuclides. If one were to obtain gamma spectroscopy measurements for about fifty bucket-sized waste samples, CDFs for the corresponding ratios could be obtained at much less expense than for destructive analyses (such as ashing) of buckets. The CDFs for the "bucket" distributions should be much steeper and have much smaller variances because of the much larger

integrations of mass in comparison to the smear samples. One required assumption is that the reduction in variance as a function of mass of material observed for gamma-to-gamma distributions must be proportional to the alpha-to-gamma ratio distributions. Distributions for larger accumulations of mass (i.e., the waste content in a 55 gallon drum) would have even smaller variances. Based on the REDC operational process, it is expected that the geometric means of the CDFs for the smear sample distributions, the 3 gallon bucket distributions, and the 55 gallon drum distributions should be the same. A directionally shielded portable HPGe detector can be used to obtain the gamma-to-gamma activity ratio for various accumulations of mass in a waste container since only ratio data are required. As a result, individual waste drums would not need to be moved from REDC to another facility for NDA measurement.

In conclusion, if the distribution of radionuclides can be shown to vary as a function of the cumulation of mass in the waste samples, the nonparametric method can be used to accurately predict the waste classification for an REDC waste package. However, if individual activity ratio sets can be proven to be lognormally distributed, the parametric method is also a favorable alternative approach to be used for estimating the concentration of those alpha-emitting radionuclides that are essentially impossible to measure using NDA techniques.

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APPENDIXES

APPENDIX A
Radiochemical data obtained from the REDC pilot study

A1. THE 1st SET OF OBSERVATION (RH SERIES, 34 SAMPLES)

Analysis		RH9AA	RH9EE	RH9KK	RH9LL	RH9QQ
Gross Alpha	(Bq/total)	9.1E+03 ± 1.9E+02	6.2E+05 ± 7.4E+03	5.8E+04 ± 1.0E+03	1.2E+04 ± 2.5E+02	1.9E+05 ± 2.5E+03
Alpha emitters						
^{244}Cm	(Bq/total)	8.3E+03 ± 8.3E+02	6.0E+05 ± 6.0E+04	5.2E+04 ± 5.2E+03	1.1E+04 ± 1.1E+03	1.8E+05 ± 1.8E+04
^{238}Pu	(Bq/total)	1.7E+02 ± 3.4E+01	< 6.2E+03	8.5E+02 ± 1.7E+02	< 1.2E+02	< 1.9E+03
$^{239/240}$Pu	(Bq/total)	< 9.1E+01	6.2E+02 ± 1.2E+02	5.8E+01 ± 1.2E+01	< 1.2E+02	5.7E+02 ± 1.1E+02
^{241}Am	(Bq/total)	1.7E+02 ± 5.4E+00	2.8E+03 ± 2.2E+01	2.5E+02 ± 6.7E+00	8.5E+02 ± 1.5E+01	5.6E+03 ± 2.0E+01
^{243}Am	(Bq/total)	1.1E+01 ± 2.0E+00	2.1E+02 ± 6.9E+00	1.1E+01 ± 2.3E+00	4.2E+01 ± 4.7E+00	1.2E+02 ± 8.3E+00
^{252}Cf	(Bq/total)	2.3E+02 ± 4.6E+01	3.1E+03 ± 6.2E+02	2.7E+03 ± 5.5E+02	1.8E+02 ± 3.6E+01	3.4E+03 ± 6.8E+02
^{242}Cm	(Bq/total)	1.9E+02 ± 3.8E+01	1.6E+04 ± 3.2E+03	2.2E+03 ± 4.4E+02	1.2E+02 ± 2.4E+01	4.0E+03 ± 8.0E+02
^{244}Cm	(Bq/total)	< 9.1E+01	6.2E+02 ± 1.2E+02	< 5.8E+02	< 1.2E+02	< 1.9E+03
Beta/gamma emitters						
^{60}Co	(Bq/total)	< 7.4E+00	< 2.1E+01	< 5.8E+00	< 2.6E+01	< 2.4E+01
^{106}Ru	(Bq/total)	1.1E+02 ± 2.5E+01	1.1E+03 ± 6.8E+01	1.8E+02 ± 2.5E+01	4.7E+03 ± 1.0E+02	9.8E+02 ± 9.0E+01
^{110m}Ag	(Bq/total)	< 5.7E+00	1.2E+02 ± 4.9E+00	< 6.2E+00	1.2E+02 ± 5.3E+00	1.1E+02 ± 5.2E+00
^{125}Sb	(Bq/total)	< 2.0E+01	4.7E+02 ± 1.7E+01	1.2E+02 ± 6.3E+00	8.6E+02 ± 1.8E+01	3.5E+02 ± 1.6E+01
^{134}Cs	(Bq/total)	1.6E+01 ± 1.6E+00	1.9E+02 ± 5.2E+00	1.9E+01 ± 1.8E+00	1.8E+02 ± 5.8E+00	1.4E+02 ± 5.7E+00
^{137}Cs	(Bq/total)	9.8E+01 ± 4.9E+00	1.9E+03 ± 1.7E+01	1.8E+02 ± 5.5E+00	1.6E+03 ± 1.6E+01	1.3E+03 ± 1.5E+01
^{144}Ce	(Bq/total)	2.2E+02 ± 1.4E+01	2.6E+03 ± 4.3E+01	1.3E+02 ± 1.2E+01	1.8E+03 ± 3.7E+01	2.0E+03 ± 4.0E+01
^{152}Eu	(Bq/total)	< 3.4E+01	3.1E+02 ± 1.1E+01	< 2.7E+01	1.6E+02 ± 7.6E+00	1.5E+02 ± 4.5E+01
^{154}Eu	(Bq/total)	1.5E+02 ± 4.0E+00	1.3E+03 ± 1.1E+01	1.1E+02 ± 3.1E+00	8.3E+02 ± 9.0E+00	2.2E+03 ± 1.4E+01
^{155}Eu	(Bq/total)	9.1E+01 ± 3.8E+00	6.1E+02 ± 6.1E+01	5.1E+01 ± 3.6E+00	4.3E+02 ± 1.0E+01	3.3E+03 ± 1.8E+01
^{239}Np	(Bq/total)	1.1E+01 ± 3.5E+00	5.3E+02 ± 2.0E+01	< 1.5E+01	< 4.4E+01	3.2E+02 ± 5.0E+01

Analysis		RH9SS			RH9D			RH9E			RH9F			RH9J		
Gross Alpha	(Bq/total)		6.1E+04	±	1.1E+03		4.8E+04	±	1.2E+03		2.6E+04	±	4.9E+02		1.0E+05	±	1.9E+03		5.2E+04	±	1.1E+03
Alpha emitters																					
^{244}Cm	(Bq/total)		5.8E+04	±	5.8E+03		4.6E+04	±	4.6E+03		2.4E+04	±	2.4E+03		9.7E+04	±	9.7E+03		4.2E+04	±	4.2E+03
^{238}Pu	(Bq/total)		1.1E+02	±	2.2E+01	<	4.8E+02				3.0E+02	±	6.0E+01	<	1.0E+03				2.7E+02	±	5.4E+01
$^{239/240}$Pu	(Bq/total)		1.2E+02	±	2.4E+01	<	4.8E+02			<	2.6E+02				5.0E+02	±	1.0E+02	<	5.2E+02		
^{241}Am	(Bq/total)		6.2E+02	±	1.1E+01		1.0E+03	±	1.8E+01		3.5E+02	±	9.0E+00		4.6E+02	±	2.3E+01		7.2E+02	±	1.9E+01
^{243}Am	(Bq/total)		3.6E+01	±	3.8E+00		2.8E+01	±	6.0E+00		3.2E+01	±	5.0E+00		2.4E+01	±	6.4E+00		2.9E+01	±	5.7E+00
^{252}Cf	(Bq/total)		1.2E+03	±	2.3E+02		8.8E+02	±	1.9E+02		7.2E+02	±	1.4E+02		8.1E+02	±	1.6E+02		7.1E+03	±	1.4E+03
^{243}Cm	(Bq/total)		7.3E+02	±	1.5E+02		8.0E+02	±	1.6E+02		1.7E+02	±	3.3E+01		5.9E+02	±	1.2E+02		2.2E+03	±	4.4E+02
^{244}Cm	(Bq/total)	<	6.1E+02			<	4.8E+02			<	2.6E+02				4.0E+02	±	8.0E+01	<	5.2E+02		
Beta/gamma emitters																					
^{60}Co	(Bq/total)	<	1.5E+01				3.0E+01	±	5.0E+00	<	1.4E+01			<	1.9E+01			<	2.1E+01		
^{106}Ru	(Bq/total)		5.1E+02	±	4.7E+01		1.8E+03	±	8.5E+01		2.3E+02	±	4.1E+01		4.6E+02	±	8.6E+01		1.9E+03	±	1.1E+02
^{110m}Ag	(Bq/total)	<	1.0E+01			<	1.4E+01				3.9E+01	±	3.7E+00		4.6E+02	±	9.0E+00	<	2.2E+01		
^{125}Sb	(Bq/total)		3.2E+02	±	1.2E+01		9.7E+01	±	1.8E+01		9.9E+01	±	1.3E+01	<	5.6E+01				2.9E+02	±	2.6E+01
^{134}Cs	(Bq/total)		1.1E+02	±	3.9E+00		8.4E+01	±	5.7E+00		4.1E+01	±	4.3E+00		9.9E+01	±	6.6E+00		2.0E+02	±	8.1E+00
^{137}Cs	(Bq/total)		7.0E+02	±	1.2E+01		5.7E+02	±	1.5E+01		6.2E+02	±	1.4E+01		1.2E+03	±	2.0E+01		1.8E+03	±	2.4E+01
^{144}Ce	(Bq/total)		1.7E+03	±	3.2E+01		5.2E+02	±	3.2E+01		3.5E+02	±	2.7E+01		8.9E+02	±	5.0E+01		1.2E+03	±	5.5E+01
^{152}Eu	(Bq/total)		2.8E+02	±	7.2E+00	<	7.4E+01			<	6.5E+01			<	5.3E+01			<	8.8E+01		
^{154}Eu	(Bq/total)		7.9E+02	±	8.2E+00		4.3E+02	±	1.0E+01		2.8E+02	±	8.1E+00		2.4E+02	±	1.1E+01		4.7E+02	±	1.4E+01
^{155}Eu	(Bq/total)		3.3E+02	±	8.2E+00		4.2E+02	±	1.1E+01		1.3E+02	±	7.4E+00		2.5E+02	±	1.4E+01		3.0E+02	±	1.6E+01
^{239}Np	(Bq/total)		1.0E+02	±	2.4E+01	<	5.2E+01			<	3.3E+01				9.9E+01	±	2.0E+01	<	5.2E+01		

Analysis		RH9M			RH9A			RH9C			RH9G			RH9H		
Gross Alpha	(Bq/total)	1.0E+05	±	1.6E+03	1.1E+04	±	2.9E+02	3.5E+04	±	1.0E+03	2.9E+04	±	5.2E+02	5.1E+04	±	1.2E+03
Alpha emitters																
^{244}Cm	(Bq/total)	9.3E+04	±	9.3E+03	1.0E+04	±	1.0E+03	3.3E+04	±	3.3E+03	2.8E+04	±	2.8E+03	4.9E+04	±	4.9E+03
^{238}Pu	(Bq/total)	1.0E+02	±	2.0E+01	1.3E+02	±	2.6E+01	4.2E+02	±	8.3E+01	8.0E+02	±	1.6E+02	2.9E+01	±	5.8E+00
$^{239/240}$Pu	(Bq/total)	4.0E+02	±	8.0E+01	< 1.1E+02			< 3.5E+02			2.6E+02	±	5.2E+01	< 5.1E+02		
^{241}Am	(Bq/total)	1.4E+03	±	2.2E+01	2.2E+02	±	6.3E+00	7.4E+02	±	1.1E+01	1.6E+02	±	5.4E+00	9.4E+02	±	1.2E+01
^{243}Am	(Bq/total)	8.9E+01	±	9.0E+00	5.1E+00	±	1.8E+00	2.1E+01	±	2.6E+00	8.9E+00	±	2.4E+00	4.6E+01	±	3.7E+00
^{252}Cf	(Bq/total)	3.2E+03	±	6.4E+02	2.8E+02	±	5.7E+01	6.6E+02	±	1.3E+02	1.5E+02	±	3.1E+01	7.0E+02	±	1.4E+02
^{243}Cm	(Bq/total)	2.0E+03	±	4.0E+02	1.7E+02	±	3.4E+01	5.3E+02	±	1.1E+02	1.1E+02	±	2.2E+01	4.3E+02	±	8.5E+01
^{245}Cm	(Bq/total)	< 1.0E+03			< 1.1E+02			< 3.5E+02			< 2.9E+02			< 5.1E+02		
Beta/gamma emitters																
^{60}Co	(Bq/total)	2.0E+01	±	5.0E+00	5.0E+00	±	2.3E+00	< 8.0E+00			8.7E+00	±	1.9E+00	1.2E+01	±	2.6E+00
^{106}Ru	(Bq/total)	7.6E+02	±	9.0E+01	1.5E+02	±	2.8E+01	3.1E+02	±	3.9E+01	1.2E+02	±	2.7E+01	4.5E+02	±	4.7E+01
^{110m}Ag	(Bq/total)	< 2.3E+01			< 7.0E+00			< 1.1E+01			2.3E+01	±	2.1E+00	6.2E+01	±	3.2E+00
^{125}Sb	(Bq/total)	5.3E+02	±	2.6E+01	< 2.1E+01			1.4E+02	±	9.0E+00	5.0E+01	±	7.6E+00	1.5E+02	±	1.0E+01
^{134}Cs	(Bq/total)	2.1E+02	±	8.5E+00	1.7E+01	±	2.0E+00	3.3E+01	±	3.1E+00	1.9E+01	±	2.0E+00	4.9E+01	±	3.0E+00
^{137}Cs	(Bq/total)	2.5E+03	±	2.9E+01	1.9E+02	±	6.0E+00	3.7E+02	±	8.0E+00	1.7E+02	±	6.0E+00	5.0E+02	±	9.3E+00
^{144}Ce	(Bq/total)	1.9E+03	±	5.4E+01	2.1E+02	±	1.5E+01	5.2E+02	±	2.1E+01	1.0E+02	±	1.2E+01	4.0E+02	±	2.1E+01
^{152}Eu	(Bq/total)	4.6E+02	±	1.6E+01	< 3.6E+01			8.5E+01	±	5.7E+00	< 3.4E+01			< 4.4E+01		
^{154}Eu	(Bq/total)	1.6E+03	±	1.6E+01	1.4E+02	±	3.6E+00	4.0E+02	±	5.7E+00	1.8E+02	±	4.5E+00	6.5E+02	±	6.8E+00
^{155}Eu	(Bq/total)	7.8E+02	±	1.7E+01	1.2E+02	±	4.1E+00	3.7E+02	±	5.9E+00	1.1E+02	±	4.2E+00	4.5E+02	±	8.0E+00
^{239}Np	(Bq/total)	1.3E+02	±	3.4E+01	< 1.9E+01			5.9E+01	±	1.2E+01	< 1.9E+01			< 9.0E+01		

Analysis		RH9I			RH9K			RH9L			RH9N			RH9P		
Gross Alpha	(Bq/total)	6.3E+04	±	1.4E+03	1.1E+05	±	2.0E+03	6.0E+04	±	1.4E+03	1.9E+05	±	2.3E+03	9.9E+04	±	1.9E+03
Alpha emitters																
^{244}Cm	(Bq/total)	6.0E+04	±	6.0E+03	1.0E+05	±	1.0E+04	5.5E+04	±	5.5E+03	1.7E+05	±	1.7E+04	9.4E+04	±	9.4E+03
^{238}Pu	(Bq/total)	3.5E+01	±	7.0E+00	6.8E+02	±	1.4E+02	5.0E+02	±	1.0E+02	< 1.9E+03			< 9.9E+02		
$^{239/240}$Pu	(Bq/total)	2.5E+02	±	5.0E+01	4.4E+02	±	8.8E+01	3.0E+02	±	6.0E+01	1.1E+03	±	2.3E+02	4.0E+02	±	7.9E+01
^{241}Am	(Bq/total)	9.1E+02	±	1.3E+01	1.3E+03	±	1.6E+01	8.2E+02	±	1.2E+01	1.1E+04	±	5.4E+01	2.2E+03	±	2.6E+01
^{243}Am	(Bq/total)	4.2E+01	±	3.7E+00	8.1E+01	±	6.2E+00	3.4E+01	±	4.4E+00	1.0E+02	±	1.5E+01	9.6E+01	±	7.1E+00
^{252}Cf	(Bq/total)	9.4E+02	±	1.9E+02	3.1E+03	±	6.1E+02	1.9E+03	±	3.8E+02	2.9E+03	±	5.9E+02	1.2E+03	±	2.4E+02
^{242}Cm	(Bq/total)	7.6E+02	±	1.5E+02	2.4E+03	±	4.9E+02	1.3E+03	±	2.6E+02	2.4E+03	±	4.7E+02	8.0E+02	±	1.6E+02
^{246}Cm	(Bq/total)	< 6.3E+02			3.3E+02	±	6.6E+01	< 6.0E+02			< 1.9E+03			< 9.9E+02		
Beta/gamma emitters																
^{60}Co	(Bq/total)	2.2E+01	±	3.7E+00	3.5E+01	±	4.1E+00	< 1.1E+01			< 2.2E+01			2.7E+01	±	5.5E+00
^{106}Ru	(Bq/total)	4.9E+02	±	5.1E+01	4.2E+02	±	6.0E+01	3.2E+02	±	5.3E+01	9.1E+02	±	1.1E+02	3.7E+02	±	9.7E+01
^{110m}Ag	(Bq/total)	4.7E+01	±	3.3E+00	< 1.4E+01			< 1.2E+01			< 2.7E+01			< 1.9E+01		
^{125}Sb	(Bq/total)	3.2E+02	±	1.2E+01	3.0E+02	±	1.5E+01	< 4.0E+01			8.8E+02	±	3.1E+01	6.0E+02	±	2.3E+01
^{134}Cs	(Bq/total)	8.9E+01	±	3.8E+00	1.3E+02	±	5.0E+00	5.8E+01	±	4.3E+00	1.7E+02	±	1.0E+01	1.0E+02	±	6.5E+00
^{137}Cs	(Bq/total)	9.9E+02	±	1.2E+01	1.4E+03	±	1.7E+01	6.5E+02	±	1.1E+01	1.5E+03	±	2.4E+01	1.2E+03	±	2.0E+01
^{144}Ce	(Bq/total)	5.5E+02	±	2.3E+01	2.6E+03	±	4.0E+01	1.3E+03	±	2.7E+01	1.9E+03	±	6.0E+01	7.6E+02	±	4.1E+01
^{152}Eu	(Bq/total)	8.5E+01	±	1.4E+01	5.9E+02	±	9.0E+00	2.8E+02	±	1.5E+01	4.4E+02	±	1.6E+01	< 9.9E+01		
^{154}Eu	(Bq/total)	5.9E+02	±	8.0E+00	1.8E+03	±	1.2E+01	8.8E+02	±	8.6E+00	5.4E+03	±	2.7E+01	9.7E+02	±	1.4E+01
^{155}Eu	(Bq/total)	3.7E+02	±	7.4E+00	8.4E+02	±	1.2E+01	4.1E+02	±	1.2E+01	9.6E+03	±	4.0E+01	3.9E+02	±	2.0E+01
^{239}Np	(Bq/total)	7.4E+01	±	1.6E+01	1.3E+02	±	1.9E+01	7.2E+01	±	1.8E+01	5.2E+02	±	5.2E+01	1.3E+02	±	1.5E+01

Analysis		RH9Q			RH9S			RH9T			RH9U			RH9V		
Gross Alpha	(Bq/total)		8.7E+04	±	1.7E+03		1.5E+05	±	2.4E+03		1.6E+04	±	3.5E+02		1.6E+04	±	3.5E+02		5.9E+04	±	5.9E+02
Alpha emitters																					
^{244}Cm	(Bq/total)		8.2E+04	±	8.2E+03		1.5E+05	±	1.5E+04		1.5E+04	±	1.5E+03		1.5E+04	±	1.5E+03		5.4E+04	±	5.4E+03
^{238}Pu	(Bq/total)	<	8.7E+02			<	1.5E+03				3.9E+02	±	7.9E+01	<	1.6E+02				3.6E+02	±	7.2E+01
$^{239/240}$Pu	(Bq/total)	<	8.7E+02				1.5E+02	±	3.0E+01		2.9E+02	±	5.8E+01	<	1.6E+02				3.5E+02	±	7.1E+01
^{241}Am	(Bq/total)		3.0E+03	±	2.8E+01		2.1E+03	±	1.9E+01		8.7E+01	±	1.9E+01		3.2E+02	±	6.7E+00		7.6E+02	±	1.7E+01
^{243}Am	(Bq/total)		4.3E+01	±	7.1E+00		3.2E+02	±	8.6E+00		7.5E+00	±	8.6E+00		8.0E+00	±	2.3E+00		6.9E+01	±	7.2E+00
^{251}Cf	(Bq/total)		8.4E+02	±	1.7E+02		3.9E+02	±	7.8E+01		2.0E+02	±	4.0E+01		3.2E+02	±	6.4E+01		2.1E+03	±	4.2E+02
^{242}Cm	(Bq/total)		1.6E+03	±	3.2E+02		2.1E+02	±	4.2E+01		1.5E+02	±	3.0E+01		2.9E+02	±	5.8E+01		9.5E+02	±	1.9E+02
^{245}Cm	(Bq/total)	<	8.7E+02			<	1.5E+03				1.6E+02	±	3.2E+01	<	1.6E+02				1.8E+02	±	3.5E+01
Beta/gamma emitters																					
^{60}Co	(Bq/total)	<	1.4E+01				3.7E+01	±	3.8E+00	<	1.4E+01			<	1.0E+01				1.1E+01	±	5.1E+00
^{106}Ru	(Bq/total)	<	1.5E+02				3.1E+02	±	5.8E+01	<	1.0E+02				1.9E+02	±	2.8E+01		5.7E+02	±	8.2E+01
^{110m}Ag	(Bq/total)	<	1.7E+01			<	1.5E+01				5.0E+01	±	3.5E+00	<	7.0E+00				2.6E+01	±	4.7E+00
^{125}Sb	(Bq/total)	<	5.0E+01				1.9E+03	±	3.2E+01	<	3.0E+01			<	2.4E+01				2.2E+02	±	1.8E+01
^{134}Cs	(Bq/total)		2.8E+01	±	4.6E+00		4.4E+02	±	6.9E+00	<	1.0E+01				1.3E+01	±	2.0E+00		1.3E+02	±	6.6E+00
^{137}Cs	(Bq/total)		3.1E+02	±	1.1E+01		6.9E+03	±	3.3E+01		6.3E+01	±	5.5E+00		1.4E+02	±	5.1E+00		8.5E+02	±	1.7E+01
^{144}Ce	(Bq/total)		5.9E+02	±	3.2E+01		9.9E+01	±	2.4E+01		1.2E+02	±	1.9E+01		1.4E+02	±	1.4E+01		1.3E+03	±	4.6E+01
^{152}Eu	(Bq/total)	<	1.6E+02				1.1E+02	±	2.2E+01	<	4.8E+01			<	3.6E+01				1.4E+02	±	9.0E+00
^{154}Eu	(Bq/total)		1.4E+03	±	1.5E+01		3.4E+03	±	1.7E+01		6.8E+01	±	4.1E+00		1.2E+02	±	4.0E+00		7.3E+02	±	1.1E+01
^{155}Eu	(Bq/total)		2.2E+03	±	1.8E+01		1.3E+03	±	2.0E+02		3.7E+01	±	4.9E+00		1.0E+02	±	3.9E+00		3.6E+02	±	1.2E+01
^{239}Np	(Bq/total)		1.6E+02	±	4.0E+01		3.5E+02	±	5.3E+01	<	2.0E+01			<	1.8E+01				1.2E+02	±	2.6E+01

Analysis		RH9O	RH9R	RH1B	RH2B	RH3B
Gross Alpha	(Bq/total)	5.3E+03 ± 1.3E+02	2.2E+04 ± 4.8E+02	5.4E+04 ± 1.2E+03	6.3E+04 ± 1.4E+03	4.3E+05 ± 5.6E+03
Alpha emitters						
^{244}Cm	(Bq/total)	3.4E+03 ± 3.4E+02	2.1E+04 ± 2.1E+03	5.4E+04 ± 5.4E+03	6.2E+04 ± 6.2E+03	4.3E+05 ± 4.3E+04
^{238}Pu	(Bq/total)	4.6E+02 ± 9.1E+01	2.4E+02 ± 4.8E+01	< 5.4E+02	< 6.3E+02	< 4.3E+03
$^{239/240}$Pu	(Bq/total)	< 5.3E+01	< 2.2E+02	< 5.4E+02	< 6.3E+02	< 4.3E+03
^{241}Am	(Bq/total)	5.4E+01 ± 5.7E+00	2.2E+02 ± 6.3E+00	3.8E+02 ± 7.3E+00	6.4E+02 ± 9.3E+00	3.9E+03 ± 2.1E+01
^{243}Am	(Bq/total)	4.0E+00 ± 2.8E+00	1.0E+01 ± 2.4E+00	7.3E+00 ± 2.3E+00	2.6E+01 ± 2.7E+00	1.0E+02 ± 3.4E+00
^{252}Cf	(Bq/total)	1.4E+03 ± 2.8E+02	3.9E+02 ± 7.8E+01	5.2E+01 ± 1.0E+01	7.5E+01 ± 1.5E+01	< 4.3E+03
^{242}Cm	(Bq/total)	< 5.3E+01	3.4E+02 ± 6.7E+01	5.6E+01 ± 1.1E+01	1.1E+02 ± 2.3E+01	< 4.3E+03
^{244}Cm	(Bq/total)	< 5.3E+01	< 2.2E+02	< 5.4E+02	< 6.3E+02	< 4.3E+03
Beta/gamma emitters						
^{60}Co	(Bq/total)	< 1.0E+01	< 1.3E+01	< 8.0E+00	< 1.0E+01	< 7.0E+00
^{106}Ru	(Bq/total)	1.3E+03 ± 7.1E+01	1.6E+02 ± 3.7E+01	< 4.5E+01	< 5.6E+01	< 5.0E+01
^{110m}Ag	(Bq/total)	1.1E+03 ± 9.3E+00	< 8.4E+00	< 6.0E+00	< 6.0E+00	< 5.0E+00
^{125}Sb	(Bq/total)	1.9E+02 ± 1.3E+01	9.4E+01 ± 8.2E+00	< 1.5E+01	< 1.6E+01	< 1.3E+01
^{134}Cs	(Bq/total)	< 1.2E+01	4.0E+01 ± 2.7E+00	< 5.0E+00	< 6.0E+00	< 5.0E+00
^{137}Cs	(Bq/total)	9.9E+01 ± 6.9E+00	4.0E+02 ± 8.1E+00	3.1E+01 ± 3.5E+00	4.9E+01 ± 3.6E+00	2.1E+01 ± 3.8E+00
^{144}Ce	(Bq/total)	1.5E+02 ± 1.9E+01	2.5E+02 ± 1.5E+01	3.8E+01 ± 7.5E+00	6.4E+01 ± 1.2E+01	4.7E+01 ± 1.1E+01
^{152}Eu	(Bq/total)	< 3.4E+01	5.3E+01 ± 3.7E+00	< 2.7E+01	< 2.7E+01	< 2.8E+01
^{154}Eu	(Bq/total)	< 3.7E+01	1.9E+02 ± 4.3E+00	1.0E+02 ± 3.4E+00	9.7E+01 ± 3.7E+00	4.8E+01 ± 2.9E+00
^{155}Eu	(Bq/total)	3.3E+01 ± 5.1E+00	1.1E+02 ± 4.7E+00	1.3E+02 ± 4.5E+00	1.4E+02 ± 4.6E+00	6.6E+01 ± 7.0E+00
^{239}Np	(Bq/total)	< 1.8E+01	< 2.0E+01	4.3E+01 ± 6.6E+00	5.4E+01 ± 5.9E+00	2.3E+02 ± 8.7E+00

Analysis		RH4D			RH6C			RH7D			RH8A		
Gross Alpha	(Bq/total)	8.1E+07	±	1.1E+06	3.0E+06	±	3.0E+04	2.7E+06	±	3.5E+04	2.4E+08	±	3.1E+06
Alpha emitters													
^{244}Cm	(Bq/total)	6.9E+07	±	6.9E+06	2.9E+06	±	2.9E+05	2.5E+06	±	2.5E+05	2.4E+08	±	2.4E+07
^{238}Pu	(Bq/total)	< 8.1E+05			< 3.0E+04			< 2.7E+04			< 2.4E+06		
$^{239/240}$Pu	(Bq/total)	8.1E+04	±	1.6E+04	< 3.0E+04			5.4E+03	±	1.1E+03	< 2.4E+06		
^{241}Am	(Bq/total)	1.1E+07	±	1.0E+04	8.8E+04	±	1.1E+02	2.3E+04	±	1.1E+02	2.1E+05	±	5.2E+02
^{243}Am	(Bq/total)	6.8E+04	±	2.6E+03	1.7E+03	±	1.7E+01	1.4E+03	±	2.8E+01	2.9E+04	±	2.0E+02
^{252}Cf	(Bq/total)	1.6E+05	±	3.3E+04	1.6E+04	±	3.3E+03	6.2E+04	±	1.2E+04	6.4E+05	±	1.3E+05
^{242}Cm	(Bq/total)	1.3E+06	±	2.6E+05	2.0E+04	±	3.9E+03	8.9E+04	±	1.8E+04	3.2E+05	±	6.5E+04
^{244}Cm	(Bq/total)	< 8.1E+05			< 3.0E+04			1.1E+04	±	2.2E+03	< 2.4E+06		
Beta/gamma emitters													
^{60}Co	(Bq/total)	< 1.5E+03			2.7E+02	±	1.3E+01	1.4E+03	±	3.0E+01	1.4E+03	±	9.5E+01
^{106}Ru	(Bq/total)	< 2.9E+04			1.8E+04	±	2.8E+02	3.7E+04	±	5.4E+02	3.4E+05	±	2.3E+03
^{110m}Ag	(Bq/total)	1.2E+04	±	9.7E+02	2.9E+03	±	2.1E+01	9.7E+02	±	3.1E+01	4.1E+03	±	1.3E+02
^{125}Sb	(Bq/total)	< 8.1E+03	±		4.5E+04	±	2.3E+03	5.0E+03	±	5.0E+02	1.5E+04	±	6.9E+02
^{134}Cs	(Bq/total)	< 2.9E+03	±		2.1E+03	±	9.7E+01	1.1E+04	±	5.3E+01	8.4E+03	±	1.6E+02
^{137}Cs	(Bq/total)	3.1E+04	±	1.5E+03	2.0E+04	±	5.8E+01	8.3E+04	±	1.8E+02	5.3E+04	±	2.9E+02
^{144}Ce	(Bq/total)	4.1E+05	±	7.2E+03	1.1E+04	±	1.3E+02	4.2E+04	±	3.0E+02	8.3E+04	±	1.3E+03
^{152}Eu	(Bq/total)	4.1E+04	±	1.4E+03	4.3E+03	±	1.2E+02	1.2E+03	±	3.0E+02	8.5E+03	±	2.4E+02
^{154}Eu	(Bq/total)	3.9E+06	±	1.3E+04	1.8E+04	±	4.1E+01	1.5E+04	±	7.5E+01	1.2E+05	±	3.6E+02
^{155}Eu	(Bq/total)	7.6E+06	±	3.8E+05	1.8E+04	±	2.0E+02	8.9E+03	±	4.5E+02	1.5E+05	±	3.0E+03
^{239}Np	(Bq/total)	4.0E+05	±	2.0E+04	2.1E+03	±	2.0E+02	3.0E+03	±	3.0E+02	9.0E+04	±	9.6E+02

A2. THE 2nd SET OF OBSERVATION (LN SERIES, 28 SAMPLES)

Analysis		LN-1			LN-3			LN-4			LN-6			LN-7		
Gross Alpha	(Bq/total)	1.1E+06	±	1.9E+04	2.9E+06	±	4.4E+04	1.3E+06	±	2.1E+04	2.3E+06	±	3.9E+04	2.1E+05	±	1.2E+04
Alpha emitters																
^{244}Cm	(Bq/total)	1.1E+06	±	1.1E+05	2.8E+06	±	2.8E+05	1.3E+06	±	1.3E+05	2.3E+06	±	2.3E+05	2.0E+05	±	2.0E+04
^{238}Pu	(Bq/total)	4.7E+02	±	9.4E+01	1.4E+03	±	2.8E+02	9.8E+02	±	2.0E+02	1.7E+03	±	3.4E+02	3.4E+03	±	6.8E+02
$^{239/240}$Pu	(Bq/total)	5.1E+02	±	1.0E+02	6.3E+03	±	1.3E+03	4.0E+03	±	8.0E+02	6.3E+03	±	1.3E+03	9.5E+02	±	1.9E+02
^{242}Pu	(Bq/total)	2.0E+01	±	4.0E+00	1.5E+01	±	3.1E+00	2.0E+01	±	4.0E+00	1.6E+01	±	3.2E+00	4.8E+01	±	9.7E+00
^{241}Am	(Bq/total)	7.3E+03	±	9.5E+01	2.5E+03	±	5.4E+01	2.2E+03	±	5.2E+01	7.1E+03	±	8.1E+01	2.5E+03	±	4.7E+01
^{243}Am	(Bq/total)	4.5E+02	±	2.9E+01	5.7E+02	±	2.4E+01	4.1E+02	±	2.5E+01	6.8E+02	±	3.1E+01	8.0E+01	±	1.0E+01
^{252}Cf	(Bq/total)	1.6E+04	±	3.3E+03	2.6E+03	±	5.2E+02	2.5E+03	±	4.9E+02	3.2E+03	±	6.4E+02	4.8E+03	±	9.7E+02
^{242}Cm	(Bq/total)	8.8E+03	±	1.8E+03	3.1E+03	±	6.2E+02	2.7E+03	±	5.5E+02	3.7E+03	±	7.4E+02	3.8E+03	±	7.6E+02
^{244}Cm	(Bq/total)	< 1.1E+04			< 2.9E+04			< 1.3E+04			< 2.3E+04			< 2.1E+03		
Beta/gamma emitters																
^{60}Co	(Bq/total)	4.2E+02	±	3.0E+01	4.8E+01	±	1.2E+01	9.7E+01	±	1.2E+01	8.2E+01	±	1.6E+01	< 3.3E+01		
^{106}Ru	(Bq/total)	5.6E+04	±	7.1E+02	2.2E+03	±	2.7E+02	6.6E+03	±	2.6E+02	1.9E+03	±	3.3E+02	8.8E+02	±	1.9E+02
^{110m}Ag	(Bq/total)	2.2E+03	±	3.7E+01	< 5.4E+01			1.2E+02	±	1.5E+01	< 7.8E+01			1.5E+02	±	1.2E+01
^{125}Sb	(Bq/total)	1.7E+03	±	1.5E+02	2.5E+03	±	7.1E+01	< 1.7E+02			1.7E+03	±	1.8E+02	< 1.5E+02		
^{134}Cs	(Bq/total)	1.7E+03	±	3.6E+01	6.0E+02	±	2.0E+01	3.3E+02	±	1.9E+01	2.9E+03	±	3.6E+01	< 3.9E+01		
^{137}Cs	(Bq/total)	2.0E+04	±	1.3E+02	8.8E+03	±	8.2E+01	3.6E+03	±	5.3E+01	4.8E+04	±	1.9E+02	8.2E+02	±	2.9E+01
^{144}Ce	(Bq/total)	9.9E+03	±	2.5E+02	1.4E+03	±	1.2E+02	1.5E+03	±	1.1E+02	2.0E+03	±	1.6E+02	7.1E+02	±	8.6E+01
^{152}Eu	(Bq/total)	6.6E+02	±	3.3E+02	< 2.3E+02			4.0E+02	±	3.2E+01	5.0E+02	±	2.0E+02	4.2E+02	±	7.9E+01
^{154}Eu	(Bq/total)	4.5E+03	±	6.8E+01	3.8E+03	±	3.8E+01	1.9E+03	±	3.6E+01	3.6E+03	±	4.8E+01	1.5E+03	±	2.8E+01
^{155}Eu	(Bq/total)	2.5E+03	±	8.7E+01	1.6E+03	±	5.6E+01	9.0E+02	±	5.5E+01	1.9E+03	±	6.6E+01	9.5E+02	±	4.2E+01
^{239}Np	(Bq/total)	7.2E+02	±	9.1E+01	1.5E+03	±	6.3E+01	8.4E+02	±	9.4E+01	1.2E+03	±	1.0E+02	< 1.7E+02		

Analysis		LN-8			LN-9			LN-11			LN-13			LN-15		
Gross Alpha	(Bq/total)		1.6E+06	±	3.2E+04		2.0E+06	±	3.8E+04		1.1E+06	±	1.9E+04		2.3E+06	±	3.9E+04		4.1E+05	±	8.4E+03
Alpha emitters																					
^{244}Cm	(Bq/total)		1.6E+06	±	1.6E+05		2.0E+06	±	2.0E+05		1.1E+06	±	1.1E+05		2.3E+06	±	2.3E+05		3.8E+05	±	3.8E+04
^{238}Pu	(Bq/total)		7.9E+02	±	1.6E+02		6.6E+02	±	1.3E+02		1.3E+03	±	2.5E+02		1.1E+03	±	2.3E+02		6.3E+03	±	1.3E+03
$^{239/240}$Pu	(Bq/total)		4.7E+03	±	9.4E+02		4.9E+03	±	9.9E+02		2.0E+03	±	4.0E+02		8.9E+03	±	1.8E+03		1.8E+03	±	3.6E+02
^{242}Pu	(Bq/total)		4.4E+01	±	8.8E+00		3.9E+01	±	7.8E+00		2.0E+01	±	4.0E+00		2.0E+01	±	4.0E+00		6.6E+01	±	1.3E+01
^{241}Am	(Bq/total)		3.2E+03	±	5.3E+01		1.5E+03	±	5.7E+01		6.2E+03	±	6.5E+01		2.8E+03	±	5.4E+01		5.9E+03	±	6.8E+01
^{243}Am	(Bq/total)		3.7E+02	±	2.2E+01		3.1E+02	±	2.5E+01		4.1E+02	±	2.3E+01		3.0E+02	±	1.7E+01		2.9E+02	±	1.7E+01
^{252}Cf	(Bq/total)		2.8E+03	±	5.7E+02		1.6E+03	±	3.3E+02		5.5E+03	±	1.1E+03		2.5E+03	±	4.9E+02		1.0E+04	±	2.1E+03
^{242}Cm	(Bq/total)		3.6E+03	±	7.1E+02		6.4E+03	±	1.3E+03		1.6E+04	±	3.3E+03		2.1E+03	±	4.3E+02		5.7E+03	±	1.1E+03
^{246}Cm	(Bq/total)	<	1.6E+04			<	2.0E+04			<	1.1E+04			<	2.3E+04				3.3E+03	±	6.6E+02
Beta/gamma emitters																					
^{60}Co	(Bq/total)		1.5E+02	±	1.6E+01	<	3.9E+01				1.1E+02	±	2.1E+01	<	3.8E+01				2.9E+01	±	1.6E+01
^{106}Ru	(Bq/total)		1.8E+03	±	2.3E+02		2.3E+03	±	2.9E+02		2.2E+04	±	5.2E+02		1.0E+03	±	1.8E+02		1.0E+03	±	2.0E+02
^{110m}Ag	(Bq/total)	<	5.1E+01			<	5.5E+01				8.8E+02	±	2.8E+01	<	4.6E+01			<	5.5E+01		
^{125}Sb	(Bq/total)		1.1E+03	±	7.3E+01	<	2.0E+02				1.4E+03	±	1.2E+02	<	2.0E+02				1.0E+03	±	5.4E+01
^{134}Cs	(Bq/total)		7.3E+02	±	2.1E+01		3.1E+02	±	2.1E+01		2.9E+03	±	3.9E+01		5.4E+02	±	2.2E+01		8.0E+01	±	1.7E+01
^{137}Cs	(Bq/total)		1.1E+04	±	9.4E+01		5.2E+03	±	7.3E+01		4.5E+04	±	1.8E+02		8.6E+03	±	8.4E+01		1.0E+03	±	3.4E+01
^{144}Ce	(Bq/total)		1.5E+03	±	1.0E+02		3.9E+02	±	1.0E+02		7.3E+03	±	2.1E+02		1.2E+03	±	1.2E+02		2.2E+03	±	1.0E+02
^{152}Eu	(Bq/total)	<	2.6E+02			<	1.8E+02			<	3.0E+02			<	1.9E+02				8.3E+02	±	3.2E+01
^{154}Eu	(Bq/total)		1.8E+03	±	2.9E+01		7.9E+02	±	4.6E+01		3.4E+03	±	5.4E+01		1.3E+03	±	3.5E+01		3.4E+03	±	3.8E+01
^{155}Eu	(Bq/total)		1.1E+03	±	4.8E+01		6.7E+02	±	4.6E+01		2.4E+03	±	7.4E+01		6.2E+02	±	5.5E+01		2.6E+03	±	6.2E+01
^{239}Np	(Bq/total)		9.5E+02	±	5.1E+01		7.5E+02	±	7.6E+01		8.9E+02	±	9.2E+01		1.1E+03	±	5.9E+01		6.4E+02	±	5.5E+01

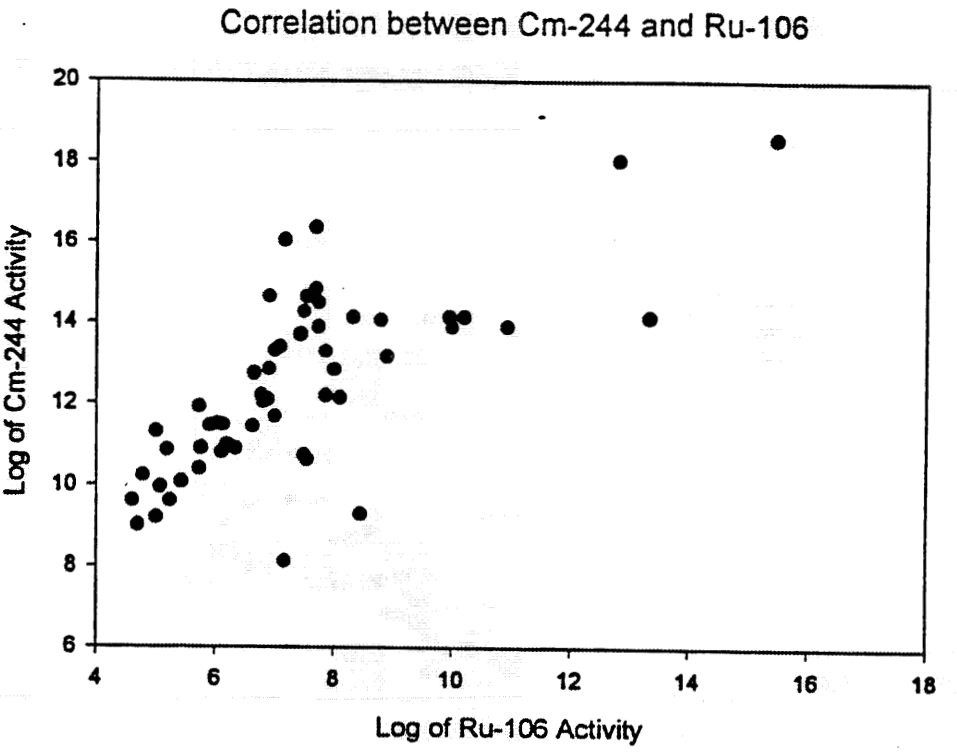
Analysis		LN-19			LN-25			LN-26			LN-28			LN-33		
Gross Alpha	(Bq/total)		9.1E+05	±	1.2E+04		6.7E+05	±	1.1E+04		1.5E+06	±	2.2E+04		1.1E+06	±	1.9E+04		1.4E+06	±	2.2E+04
Alpha emitters																					
^{244}Cm	(Bq/total)		9.0E+05	±	9.0E+04		6.6E+05	±	6.6E+04		1.4E+06	±	1.4E+05		1.1E+06	±	1.1E+05		1.4E+06	±	1.4E+05
^{238}Pu	(Bq/total)		1.1E+03	±	2.1E+02		4.4E+02	±	8.8E+01		1.1E+03	±	2.2E+02		1.4E+03	±	2.9E+02		6.4E+03	±	1.3E+03
$^{239/240}$Pu	(Bq/total)		4.0E+03	±	8.0E+02		1.1E+03	±	2.2E+02		6.9E+03	±	1.4E+03		6.6E+03	±	1.3E+03		3.6E+03	±	7.2E+02
^{242}Pu	(Bq/total)		3.2E+01	±	6.4E+00		8.0E+00	±	1.6E+00		6.5E+01	±	1.3E+01		4.9E+01	±	9.7E+00		5.0E+01	±	1.0E+01
^{241}Am	(Bq/total)		1.9E+03	±	4.5E+01		4.9E+03	±	5.5E+01		1.7E+03	±	5.4E+01		2.2E+03	±	4.9E+01		1.5E+04	±	9.3E+01
^{243}Am	(Bq/total)		1.4E+02	±	1.3E+01		2.2E+02	±	1.3E+01		2.4E+02	±	2.0E+01		2.9E+02	±	1.4E+01		1.3E+03	±	3.1E+01
^{252}Cf	(Bq/total)		2.1E+03	±	4.2E+02		1.1E+03	±	2.2E+02		5.8E+03	±	1.2E+03		2.1E+03	±	4.2E+02		1.3E+04	±	2.6E+03
^{242}Cm	(Bq/total)		6.1E+02	±	1.2E+02		2.3E+03	±	4.5E+02		5.8E+03	±	1.2E+03		1.2E+03	±	2.4E+02		9.4E+03	±	1.9E+03
^{244}Cm	(Bq/total)	<	9.1E+03				2.7E+03	±	5.4E+02	<	1.5E+04			<	1.1E+04			<	1.4E+04		
Beta/gamma emitters																					
^{60}Co	(Bq/total)	<	3.8E+01			<	3.9E+01				1.9E+02	±	2.0E+01		2.1E+01	±	1.2E+01		2.1E+02	±	2.4E+01
^{106}Ru	(Bq/total)		1.7E+03	±	2.2E+02		1.2E+03	±	1.6E+02		2.1E+04	±	4.8E+02		2.3E+03	±	2.9E+02		2.7E+04	±	6.2E+02
^{110m}Ag	(Bq/total)		1.5E+02	±	1.5E+01	<	3.4E+01				3.3E+03	±	4.0E+01	<	5.2E+01				3.7E+02	±	3.0E+01
^{125}Sb	(Bq/total)		8.6E+02	±	5.7E+01		5.8E+02	±	4.3E+01		1.5E+03	±	8.3E+01		9.9E+02	±	6.3E+01		3.2E+03	±	1.2E+02
^{134}Cs	(Bq/total)		3.3E+02	±	1.6E+01		8.3E+01	±	9.0E+00		5.5E+02	±	2.9E+01		4.6E+02	±	1.9E+01		7.1E+02	±	3.7E+01
^{137}Cs	(Bq/total)		4.6E+03	±	5.8E+01		1.1E+03	±	3.0E+01		3.5E+03	±	6.4E+01		6.9E+03	±	7.6E+01		7.8E+03	±	8.5E+01
^{144}Ce	(Bq/total)		1.0E+03	±	8.9E+01		5.8E+02	±	6.3E+01		8.6E+03	±	1.9E+02		1.1E+03	±	1.1E+02		1.0E+04	±	2.3E+02
^{152}Eu	(Bq/total)	<	1.4E+02			<	1.5E+02			<	1.8E+02			<	2.1E+02				1.5E+03	±	3.0E+02
^{154}Eu	(Bq/total)		1.1E+03	±	6.6E+01		6.8E+02	±	2.0E+01		1.0E+03	±	4.1E+01		1.3E+03	±	2.5E+01		1.7E+04	±	9.7E+01
^{155}Eu	(Bq/total)		5.2E+02	±	4.0E+01		3.2E+02	±	2.6E+01		6.4E+02	±	5.9E+01		7.0E+02	±	4.6E+01		9.6E+03	±	1.2E+02
^{239}Np	(Bq/total)		7.1E+02	±	4.6E+01		5.9E+02	±	3.5E+01		1.4E+03	±	8.8E+01		7.0E+02	±	8.5E+01		2.1E+03	±	1.2E+02

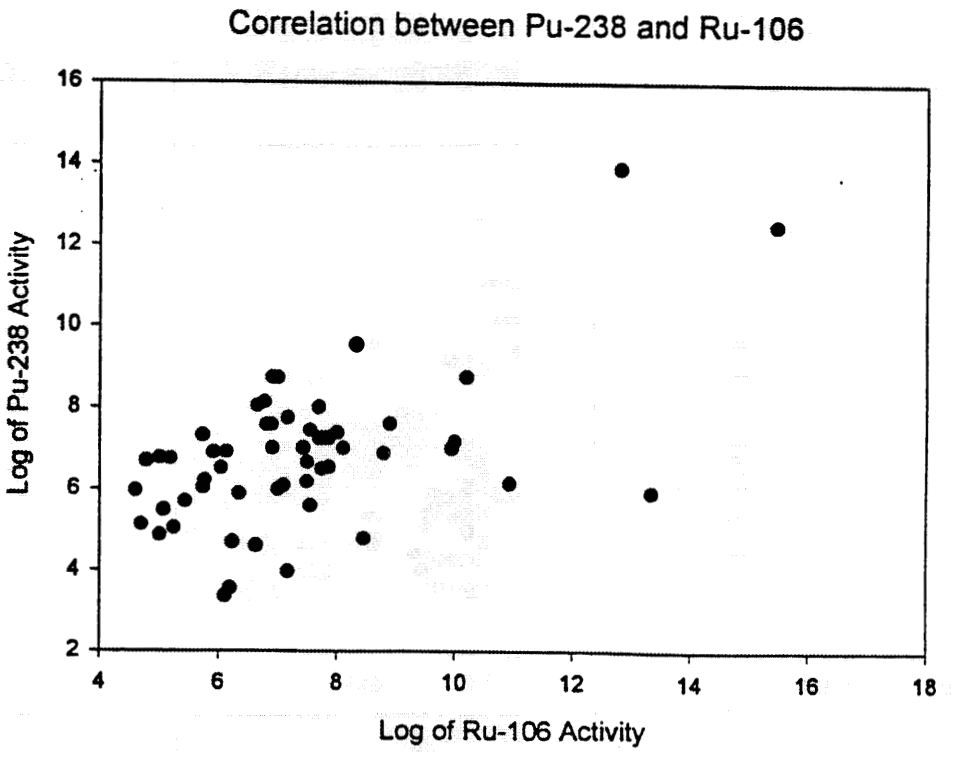
Analysis		LN-35			LN-36			LN-38			LN-39			LN-40		
Gross Alpha	(Bq/total)		1.5E+06	±	2.2E+04		9.5E+06	±	7.9E+04		2.1E+05	±	5.9E+03		1.3E+07	±	1.3E+05		1.4E+06	±	2.2E+04
Alpha emitters																					
^{244}Cm	(Bq/total)		1.4E+06	±	1.4E+05		9.4E+06	±	9.4E+05		2.0E+05	±	2.0E+04		1.3E+07	±	1.3E+06		1.4E+06	±	1.4E+05
^{238}Pu	(Bq/total)		1.4E+04	±	2.9E+03		2.3E+03	±	4.6E+02		6.9E+02	±	1.4E+02		3.0E+03	±	6.1E+02		3.8E+02	±	7.5E+01
$^{239/240}$Pu	(Bq/total)		5.5E+03	±	1.1E+03		3.8E+03	±	7.6E+02		4.8E+02	±	9.7E+01		6.2E+03	±	1.2E+03		2.9E+02	±	5.7E+01
^{242}Pu	(Bq/total)		2.0E+02	±	4.0E+01		2.4E+01	±	4.9E+00		2.8E+01	±	5.5E+00		9.3E+00	±	1.9E+00		8.7E+00	±	1.7E+00
^{241}Am	(Bq/total)		5.8E+04	±	2.0E+02		8.3E+04	±	2.4E+02		1.7E+03	±	4.1E+01		1.1E+05	±	2.7E+02		1.1E+04	±	5.9E+02
^{243}Am	(Bq/total)		3.7E+02	±	2.7E+01		1.0E+03	±	2.9E+01		1.7E+02	±	1.7E+01		1.2E+03	±	3.1E+01		5.8E+03	±	3.3E+02
^{252}Cf	(Bq/total)		2.1E+04	±	4.2E+03		4.5E+03	±	9.0E+02		1.9E+03	±	3.8E+02		5.2E+03	±	1.0E+03		1.8E+04	±	3.5E+03
^{242}Cm	(Bq/total)		1.9E+04	±	3.9E+03		5.0E+03	±	1.0E+03		1.5E+03	±	2.9E+02		7.8E+03	±	1.6E+03		1.3E+04	±	2.6E+03
^{246}Cm	(Bq/total)	<	1.5E+04				2.9E+04	±	5.7E+03		8.4E+02	±	1.7E+02		3.9E+04	±	7.8E+03	<	1.4E+04		
Beta/gamma emitters																					
^{60}Co	(Bq/total)		1.7E+02	±	2.2E+01	<	4.6E+01				9.5E+01	±	1.3E+01		5.0E+01	±	1.2E+01	<	3.7E+02		
^{106}Ru	(Bq/total)		4.1E+03	±	4.1E+02		1.3E+03	±	2.0E+02		2.6E+03	±	2.6E+02		2.2E+03	±	2.1E+02		6.2E+05	±	6.7E+03
^{110m}Ag	(Bq/total)		3.5E+02	±	2.8E+01	<	5.4E+01				1.4E+02	±	1.4E+01		2.0E+02	±	1.8E+01		3.1E+03	±	2.6E+02
^{125}Sb	(Bq/total)		2.9E+03	±	9.9E+01		1.2E+03	±	6.4E+01		6.6E+02	±	4.9E+01		1.4E+03	±	7.1E+01	<	3.0E+03		
^{134}Cs	(Bq/total)		3.3E+02	±	3.4E+01		4.1E+02	±	2.0E+01		2.3E+02	±	1.5E+01		3.0E+02	±	2.0E+01	<	1.2E+04		
^{137}Cs	(Bq/total)		3.8E+03	±	6.6E+01		6.3E+03	±	6.8E+01		1.9E+03	±	4.0E+01		4.4E+03	±	5.9E+01		1.7E+04	±	5.2E+02
^{144}Ce	(Bq/total)		6.0E+03	±	1.9E+02		1.1E+03	±	1.3E+02		1.6E+03	±	9.6E+01		7.0E+02	±	8.6E+01		1.9E+04	±	1.8E+03
^{152}Eu	(Bq/total)		1.3E+03	±	2.6E+02	<	2.1E+02			<	2.3E+02			<	2.2E+02			<	1.5E+03		
^{154}Eu	(Bq/total)		8.9E+03	±	6.7E+01		1.6E+03	±	3.5E+01		2.0E+03	±	3.1E+01		1.5E+03	±	3.6E+01		4.1E+04	±	1.4E+03
^{155}Eu	(Bq/total)		8.3E+03	±	1.1E+02		7.6E+02	±	5.8E+01		1.0E+03	±	3.8E+01		3.5E+02	±	3.9E+01		1.7E+04	±	7.3E+02
^{239}Np	(Bq/total)		1.4E+03	±	1.2E+02		4.8E+03	±	1.7E+02		2.4E+02	±	3.3E+01		3.5E+03	±	1.2E+03	<	4.3E+03		

Analysis		LN-41	LN-44	LN-46	LN-48	LN-49
Gross Alpha	(Bq/total)	5.5E+05 ± 9.7E+03	3.5E+05 ± 7.6E+03	1.9E+05 ± 1.6E+03	3.9E+05 ± 1.0E+04	1.2E+05 ± 4.4E+03
Alpha emitters						
^{244}Cm	(Bq/total)	5.3E+05 ± 5.3E+04	3.4E+05 ± 3.4E+04	1.9E+05 ± 1.9E+04	3.8E+05 ± 3.8E+04	1.2E+05 ± 1.2E+04
^{238}Pu	(Bq/total)	2.0E+03 ± 3.9E+02	3.1E+03 ± 6.3E+02	1.1E+03 ± 2.2E+02	1.6E+03 ± 3.1E+02	4.0E+02 ± 8.0E+01
$^{239/240}$Pu	(Bq/total)	2.1E+03 ± 4.2E+02	1.4E+03 ± 2.9E+02	6.8E+02 ± 1.4E+02	9.3E+02 ± 1.9E+02	4.0E+02 ± 8.0E+01
^{241}Pu	(Bq/total)	3.3E+01 ± 6.6E+00	4.6E+01 ± 9.2E+00	1.7E+01 ± 3.4E+00	1.3E+01 ± 2.5E+00	< 8.2E+01
^{241}Am	(Bq/total)	7.2E+03 ± 7.7E+01	2.2E+03 ± 4.3E+01	2.0E+03 ± 4.2E+01	3.7E+03 ± 5.6E+01	8.9E+02 ± 2.8E+01
^{243}Am	(Bq/total)	2.1E+02 ± 2.0E+01	1.9E+02 ± 1.4E+01	1.1E+02 ± 1.6E+01	1.5E+02 ± 1.3E+01	8.8E+01 ± 8.4E+00
^{252}Cf	(Bq/total)	6.0E+03 ± 1.2E+03	1.2E+03 ± 2.4E+02	1.8E+03 ± 3.5E+02	2.5E+03 ± 4.9E+02	7.8E+02 ± 1.6E+02
^{242}Cm	(Bq/total)	1.7E+03 ± 3.4E+02	4.1E+03 ± 8.1E+02	3.2E+02 ± 6.5E+01	1.4E+03 ± 2.9E+02	3.0E+02 ± 6.0E+01
^{246}Cm	(Bq/total)	4.8E+03 ± 9.6E+02	< 3.5E+03	3.8E+02 ± 7.6E+01	< 3.9E+03	< 1.2E+03
Beta/gamma emitters						
^{60}Co	(Bq/total)	1.4E+02 ± 1.4E+01	3.9E+01 ± 1.1E+01	1.1E+02 ± 1.4E+01	6.7E+01 ± 1.1E+01	3.8E+01 ± 1.0E+01
^{106}Ru	(Bq/total)	7.3E+03 ± 3.4E+02	7.8E+02 ± 1.3E+02	3.3E+03 ± 2.1E+02	3.0E+03 ± 2.8E+01	1.1E+03 ± 1.5E+02
^{110m}Ag	(Bq/total)	1.6E+02 ± 1.6E+01	2.6E+02 ± 1.3E+01	< 4.8E+01	< 4.6E+01	< 3.1E+01
^{125}Sb	(Bq/total)	3.9E+03 ± 1.1E+02	5.1E+02 ± 3.9E+01	5.3E+02 ± 4.1E+01	8.9E+02 ± 6.3E+01	2.7E+02 ± 3.1E+01
^{134}Cs	(Bq/total)	4.9E+02 ± 3.1E+01	2.6E+02 ± 1.2E+01	2.5E+02 ± 1.4E+01	3.5E+02 ± 2.2E+01	9.1E+01 ± 9.8E+00
^{137}Cs	(Bq/total)	6.3E+03 ± 6.9E+01	3.9E+03 ± 5.5E+01	2.2E+03 ± 4.2E+01	4.6E+03 ± 6.4E+01	8.7E+02 ± 3.1E+01
^{144}Ce	(Bq/total)	1.2E+03 ± 9.9E+01	1.0E+03 ± 8.7E+01	1.2E+03 ± 8.1E+01	1.3E+03 ± 9.8E+01	5.1E+02 ± 6.0E+01
^{152}Eu	(Bq/total)	< 2.1E+02	< 1.7E+02	< 1.8E+02	< 2.0E+02	< 1.7E+02
^{154}Eu	(Bq/total)	2.8E+03 ± 4.2E+01	6.0E+02 ± 1.7E+01	1.4E+03 ± 2.9E+01	2.1E+03 ± 3.5E+01	7.8E+02 ± 1.8E+01
^{155}Eu	(Bq/total)	6.8E+02 ± 4.1E+01	3.2E+02 ± 3.2E+01	1.0E+03 ± 4.2E+01	1.0E+03 ± 5.3E+01	3.8E+02 ± 2.9E+01
^{239}Np	(Bq/total)	< 2.7E+02	3.6E+02 ± 3.5E+01	2.6E+02 ± 4.0E+01	4.5E+02 ± 5.1E+01	1.6E+02 ± 3.0E+01

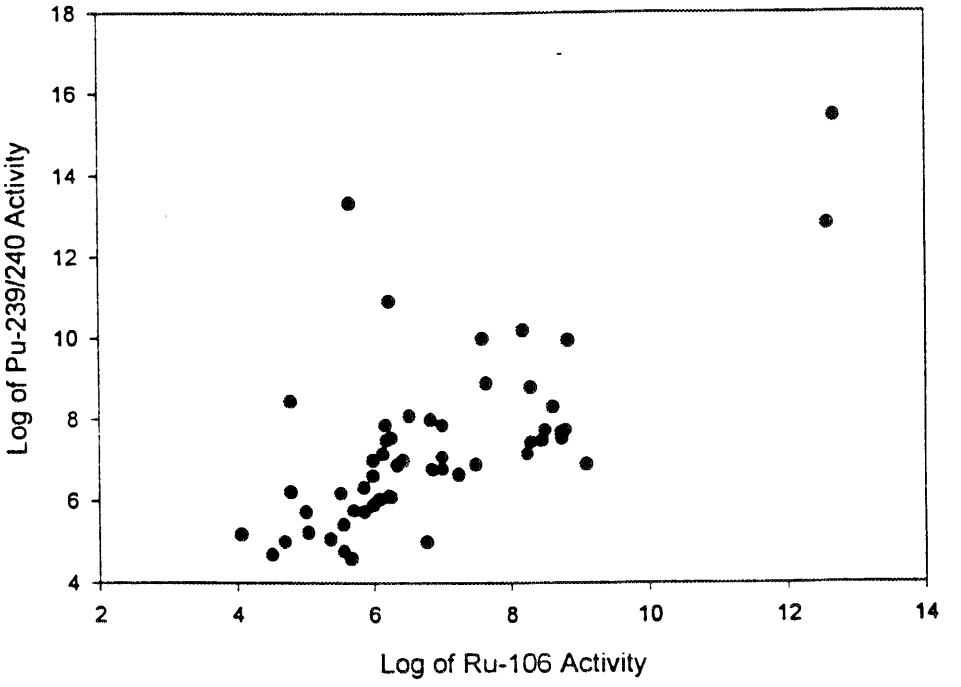
Analysis		LN-54			LN-GL			LN-ML		
Gross Alpha	(Bq/total)	6.0E+06	±	1.0E+04	1.2E+08	±	1.7E+06	7.3E+07	±	1.4E+06
Alpha emitters										
^{244}Cm	(Bq/total)	5.9E+05	±	5.9E+04	1.2E+08	±	1.2E+07	6.9E+07	±	6.9E+06
^{238}Pu	(Bq/total)	1.4E+03	±	2.8E+02	2.7E+05	±	5.5E+04	1.1E+06	±	2.2E+05
$^{239/240}$Pu	(Bq/total)	1.1E+03	±	2.3E+02	3.2E+05	±	6.4E+04	2.9E+05	±	5.8E+04
^{242}Pu	(Bq/total)	3.4E+01	±	6.8E+00	4.2E+03	±	8.4E+02	1.3E+04	±	2.5E+03
^{241}Am	(Bq/total)	5.2E+03	±	5.9E+01	6.2E+05	±	6.6E+03	9.3E+05	±	5.5E+03
^{243}Am	(Bq/total)	3.2E+02	±	1.5E+01	7.1E+04	±	1.8E+03	4.9E+04	±	1.1E+03
^{252}Cf	(Bq/total)	2.5E+03	±	4.9E+02	1.3E+06	±	2.6E+05	2.0E+06	±	4.0E+05
^{243}Cm	(Bq/total)	2.3E+03	±	4.7E+02	5.0E+05	±	1.0E+05	4.1E+05	±	8.1E+04
^{246}Cm	(Bq/total)	1.8E+03	±	3.6E+02	< 1.2E+06			< 7.3E+05		
Beta/gamma emitters										
^{60}Co	(Bq/total)	7.0E+01	±	1.3E+01	4.7E+04	±	1.6E+03	6.5E+03	±	1.0E+03
^{106}Ru	(Bq/total)	2.6E+03	±	2.2E+02	5.2E+06	±	4.6E+04	3.7E+05	±	2.2E+04
^{110m}Ag	(Bq/total)	1.5E+02	±	1.3E+01	7.7E+04	±	2.1E+03	1.7E+04	±	1.1E+03
^{125}Sb	(Bq/total)	5.6E+02	±	4.7E+01	2.3E+05	±	3.5E+04	1.1E+05	±	4.0E+03
^{134}Cs	(Bq/total)	2.2E+02	±	1.8E+01	5.0E+05	±	3.2E+03	1.4E+04	±	1.0E+03
^{137}Cs	(Bq/total)	3.0E+03	±	4.9E+01	6.7E+06	±	1.4E+04	1.5E+05	±	2.5E+03
^{144}Ce	(Bq/total)	2.7E+03	±	1.1E+02	5.5E+05	±	1.6E+04	3.3E+05	±	8.0E+03
^{152}Eu	(Bq/total)	3.2E+02	±	1.3E+02	5.6E+04	±	3.1E+03	1.4E+05	±	2.6E+03
^{154}Eu	(Bq/total)	2.6E+03	±	3.6E+01	3.9E+05	±	3.4E+03	5.2E+05	±	2.9E+03
^{155}Eu	(Bq/total)	1.3E+03	±	5.0E+01	2.4E+05	±	4.6E+03	4.4E+05	±	4.4E+04
^{239}Np	(Bq/total)	5.2E+02	±	4.2E+01	1.5E+05	±	9.6E+03	9.0E+04	±	1.8E+04

APPENDIX B
Correlation between alpha and selected gamma activity

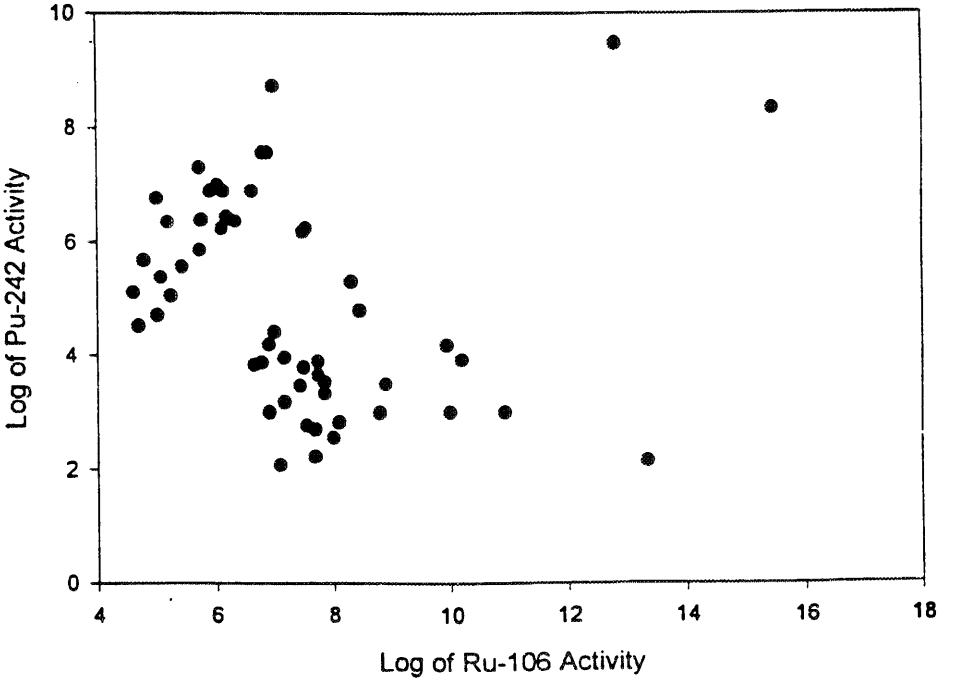

Correlation between Cm-244 and Ru-106
Log of Cm-244 Activity
Log of Ru-106 Activity
20
18
16
14
12
10
8
6
4
6
8
10
12
14
16
18

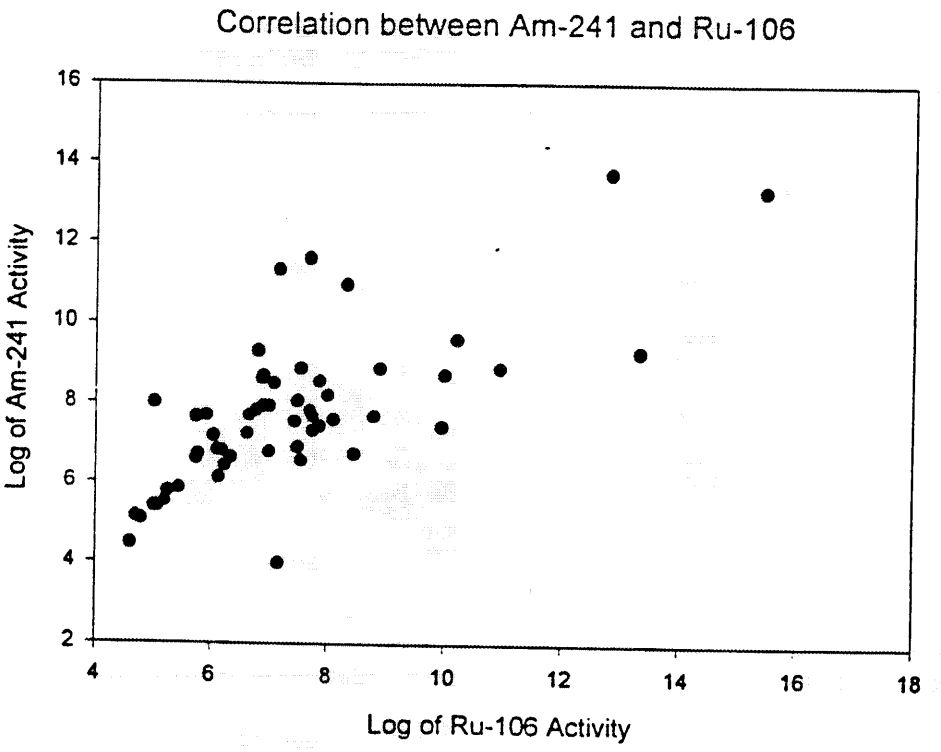

Correlation between Pu-238 and Ru-106
Log of Pu-238 Activity
Log of Ru-106 Activity
16
14
12
10
8
6
4
2
4
6
8
10
12
14
16
18

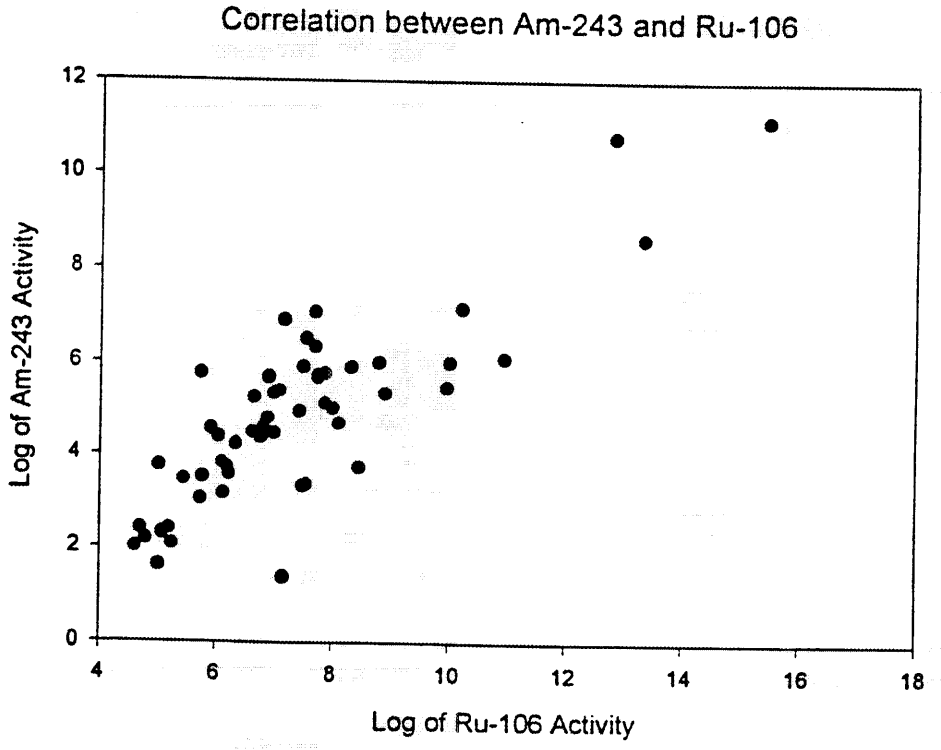
Correlation between Pu-239/Pu240 and Ru-106

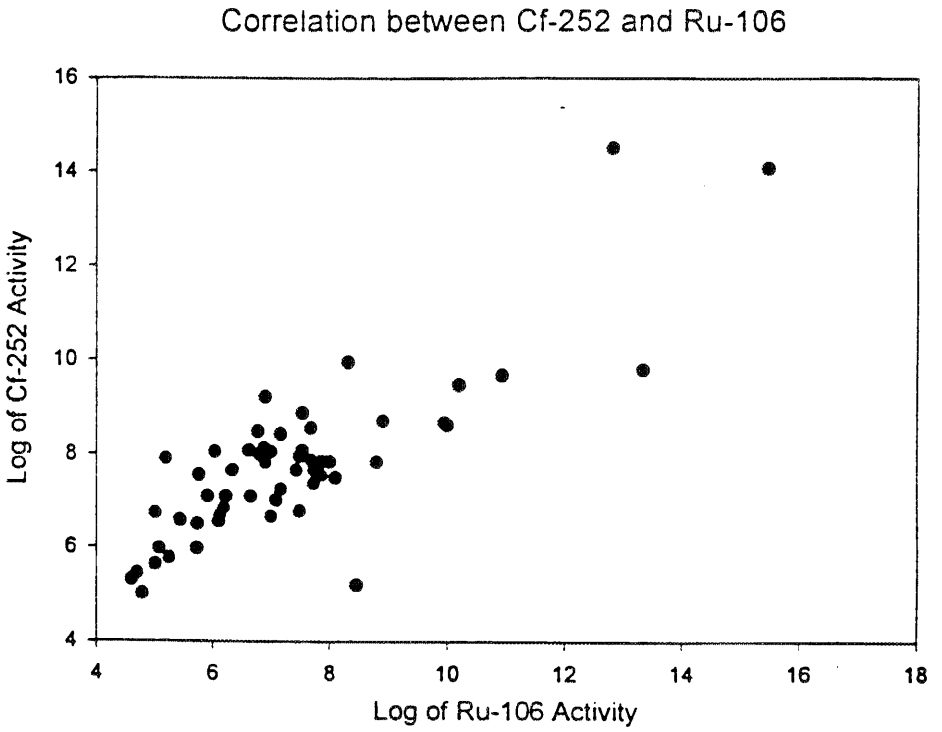


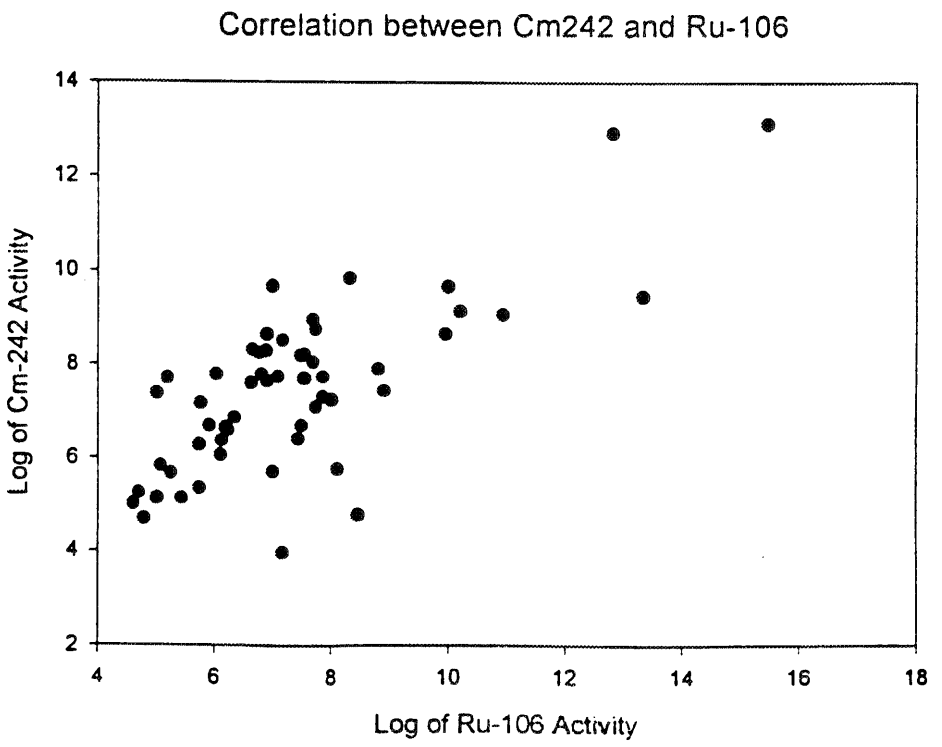
Correlation between Pu-242 and Ru-106



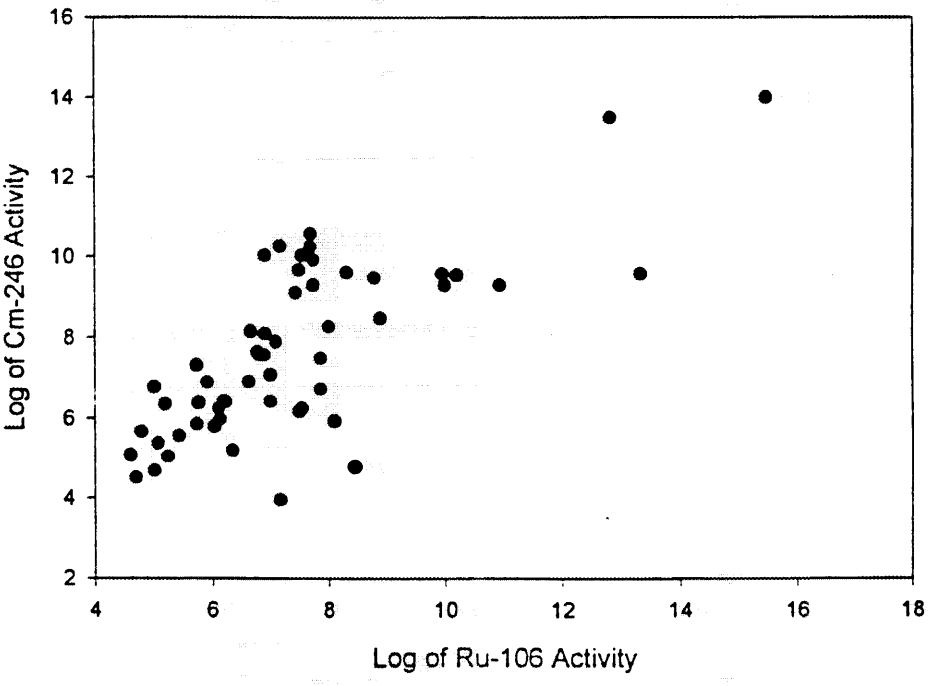

Correlation between Am-241 and Ru-106
Log of Am-241 Activity
Log of Ru-106 Activity
16
14
12
10
8
6
4
2
4
6
8
10
12
14
16
18

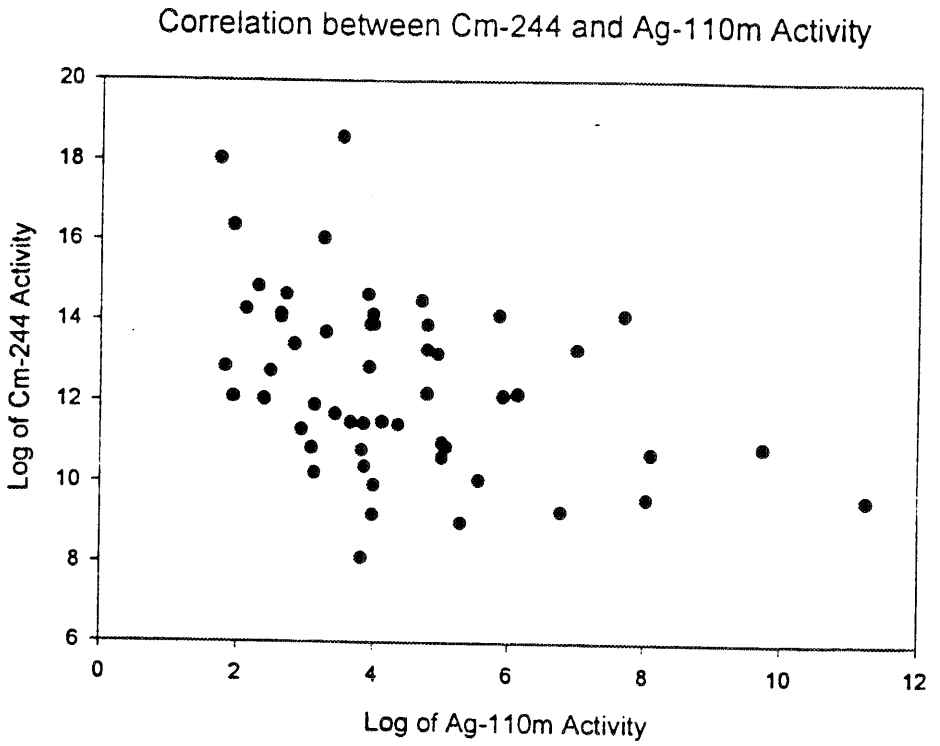

Correlation between Am-243 and Ru-106
Log of Am-243 Activity
Log of Ru-106 Activity
12
10
8
6
4
2
0
4
6
8
10
12
14
16
18

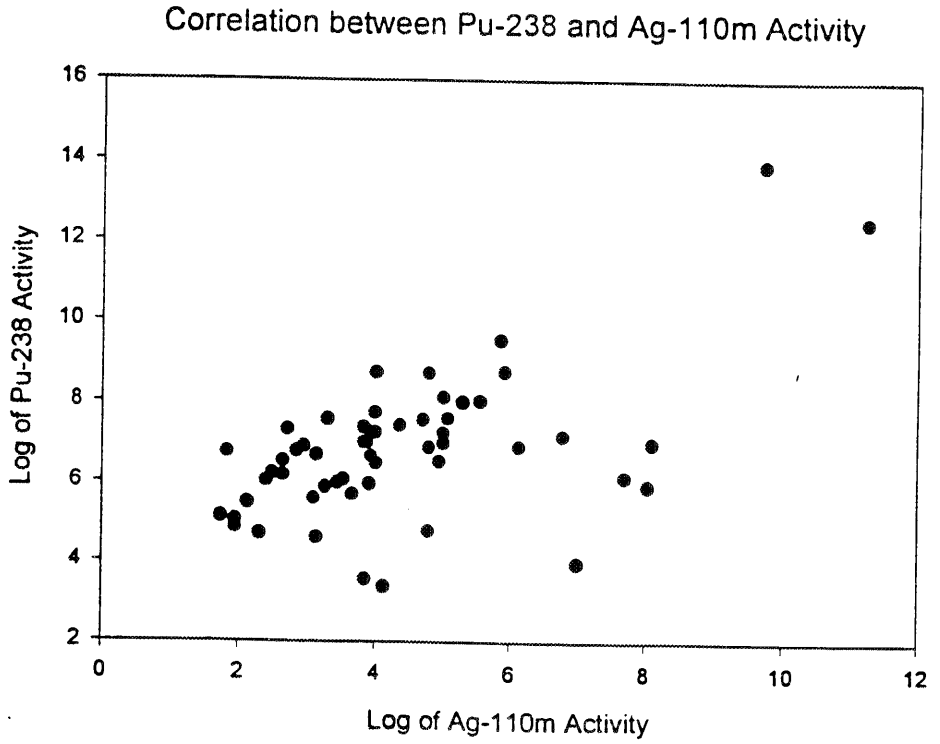

Correlation between Cf-252 and Ru-106
Log of Cf-252 Activity
Log of Ru-106 Activity
16
14
12
10
8
6
4
4
6
8
10
12
14
16
18


Correlation between Cm242 and Ru-106
Log of Cm-242 Activity
Log of Ru-106 Activity
14
12
10
8
6
4
2
4
6
8
10
12
14
16
18

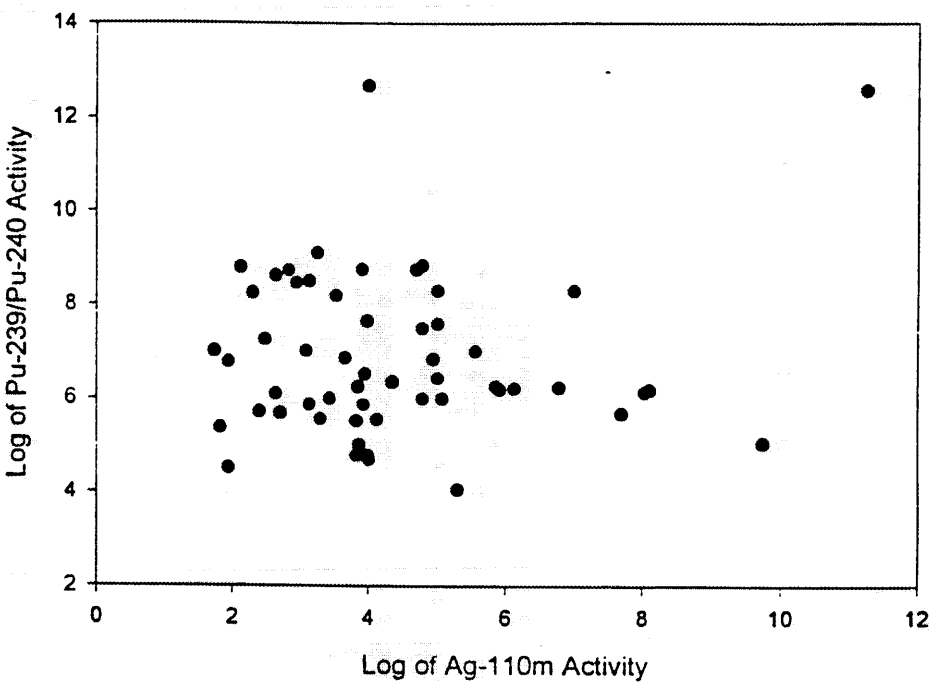
Correlation between Cm-246 and Ru-106



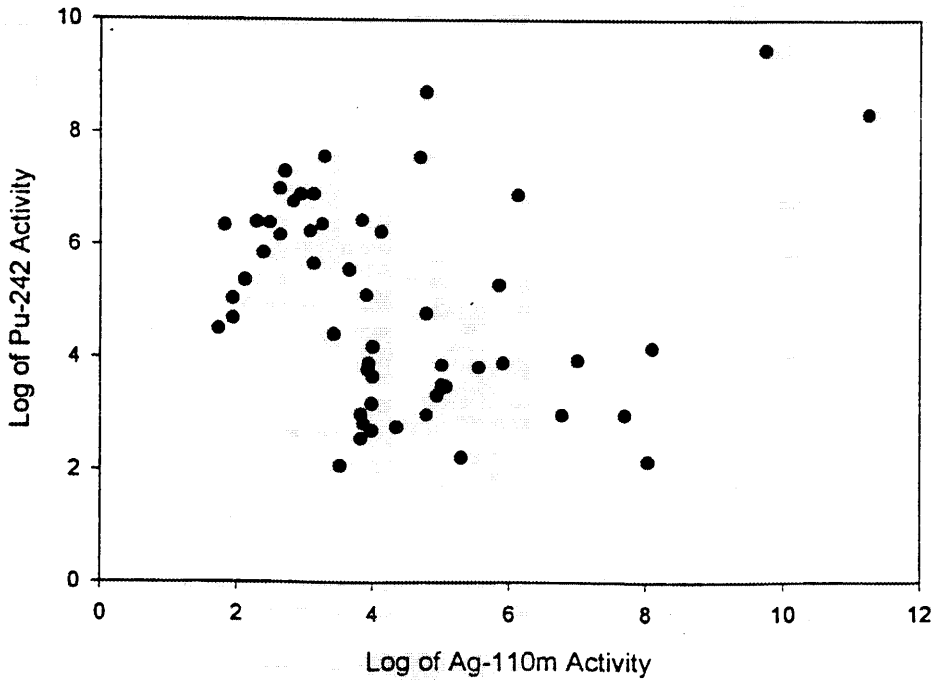

Correlation between Cm-244 and Ag-110m Activity
Log of Cm-244 Activity
Log of Ag-110m Activity
20
18
16
14
12
10
8
6
0
2
4
6
8
10
12


Correlation between Pu-238 and Ag-110m Activity
Log of Pu-238 Activity
Log of Ag-110m Activity
16
14
12
10
8
6
4
2
0
2
4
6
8
10
12

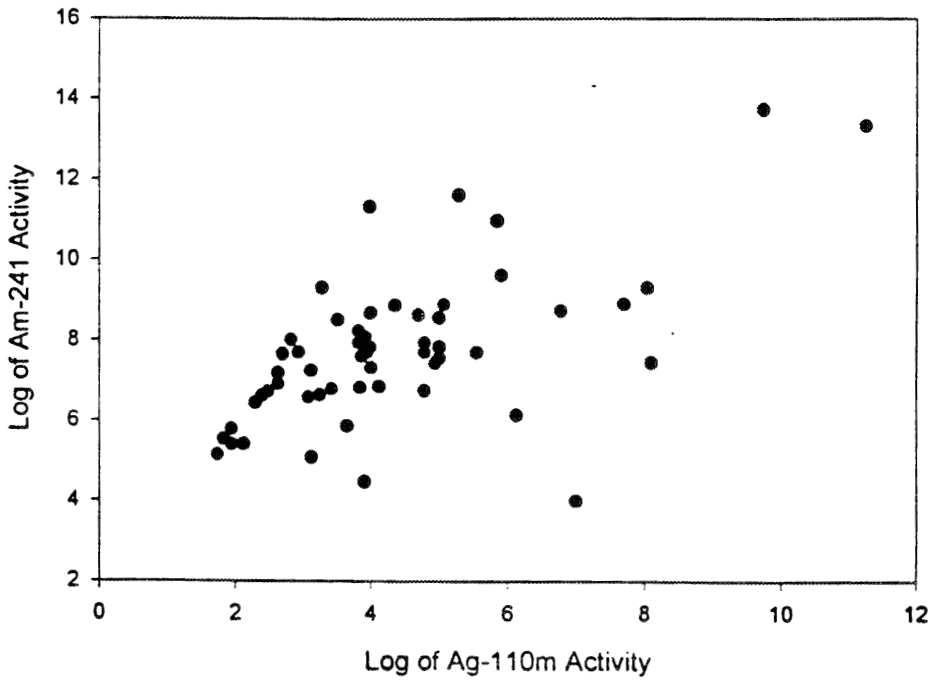
Correlation between Pu239/240 and Ag-110m Activity



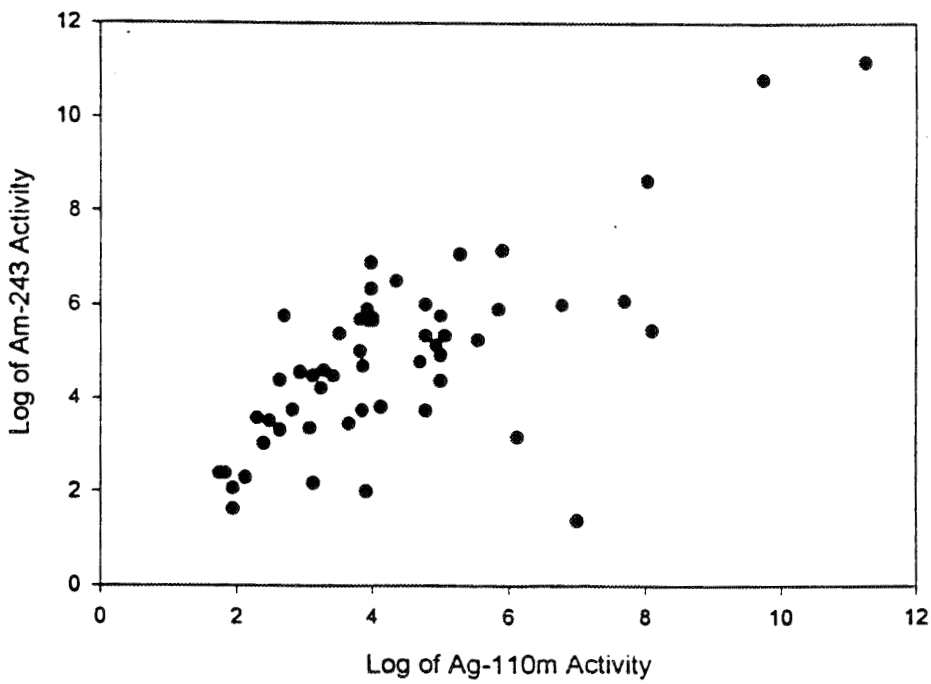
Correlation between Pu-242 and Ag-110m Activity

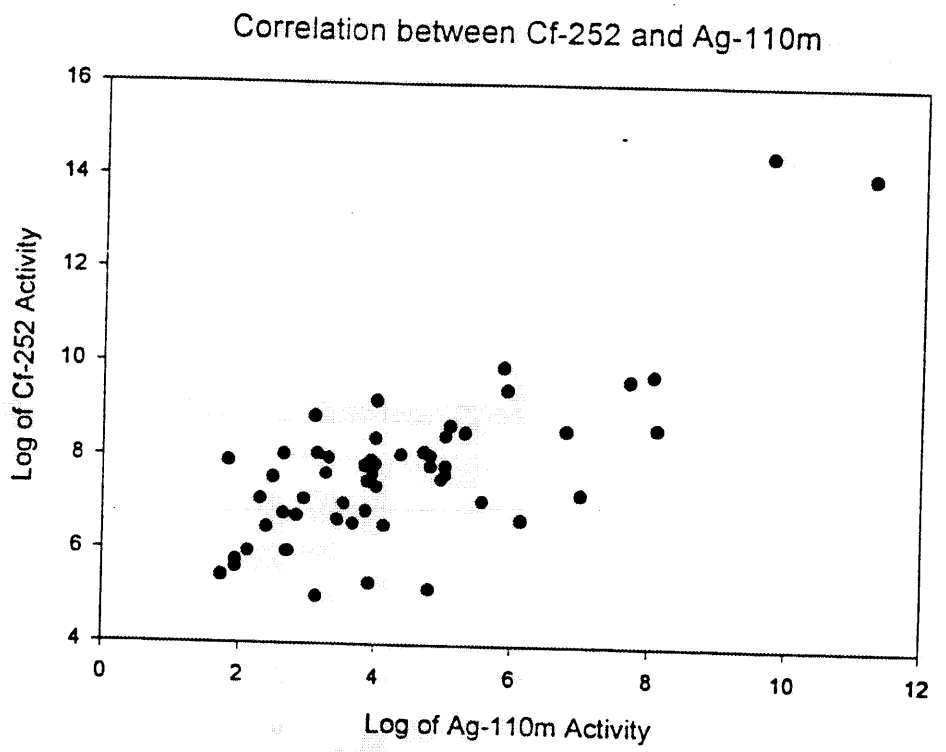


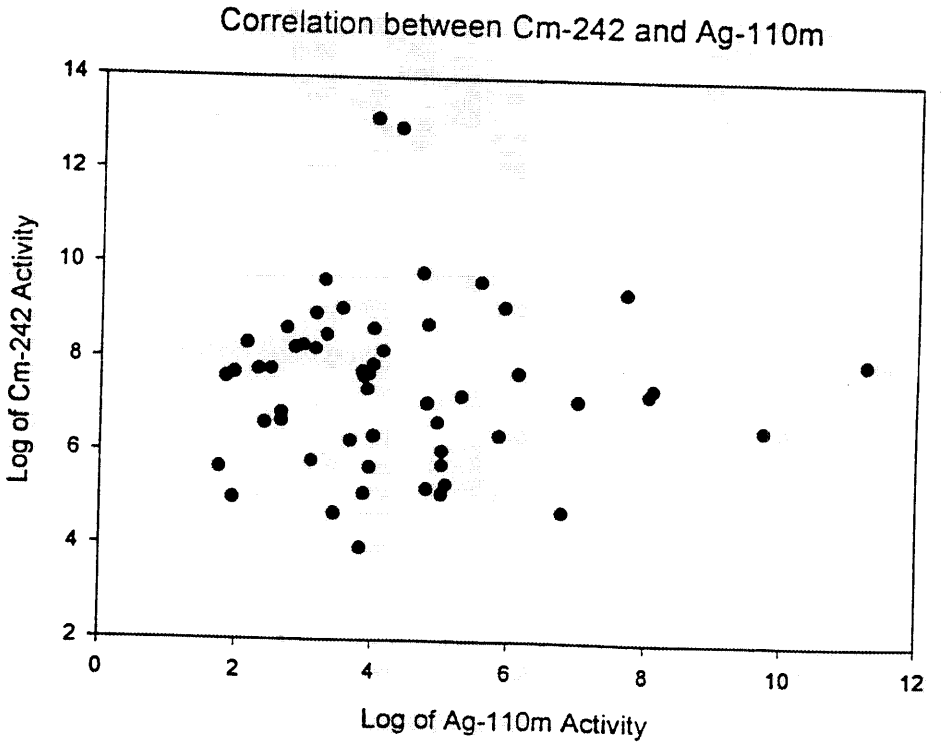
Correlation between Am-241 and Ag-110m Activity



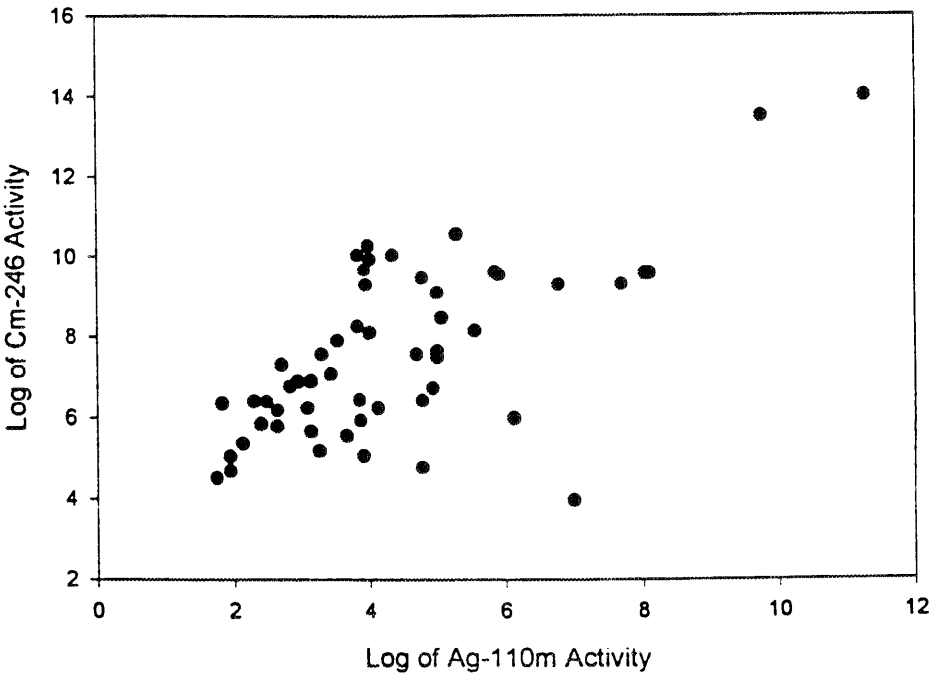
Correlation between Am-243 and Ag-110m Activity



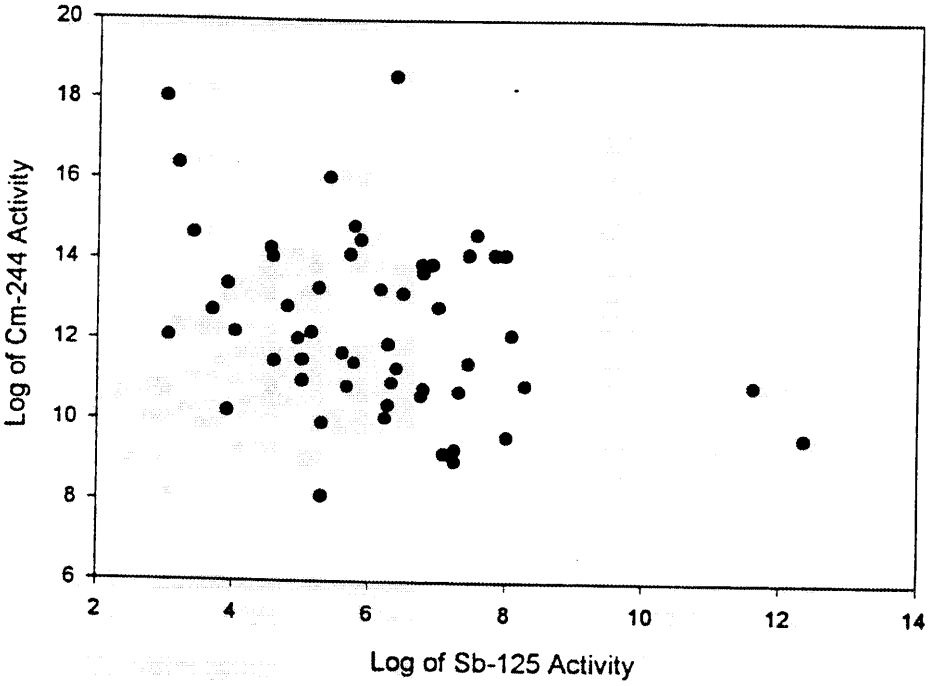

Correlation between Cf-252 and Ag-110m
Log of Cf-252 Activity
Log of Ag-110m Activity
16
14
12
10
8
6
4
0
2
4
6
8
10
12


Correlation between Cm-242 and Ag-110m
Log of Cm-242 Activity
Log of Ag-110m Activity
14
12
10
8
6
4
2
0
2
4
6
8
10
12

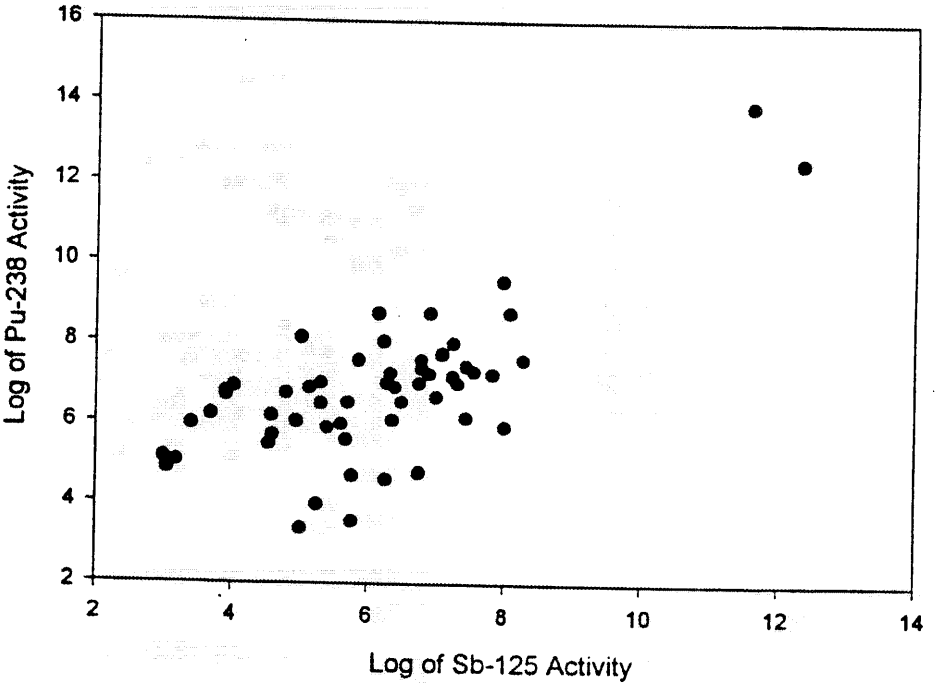
Correlation between Cm-246 and Ag-110m Activity



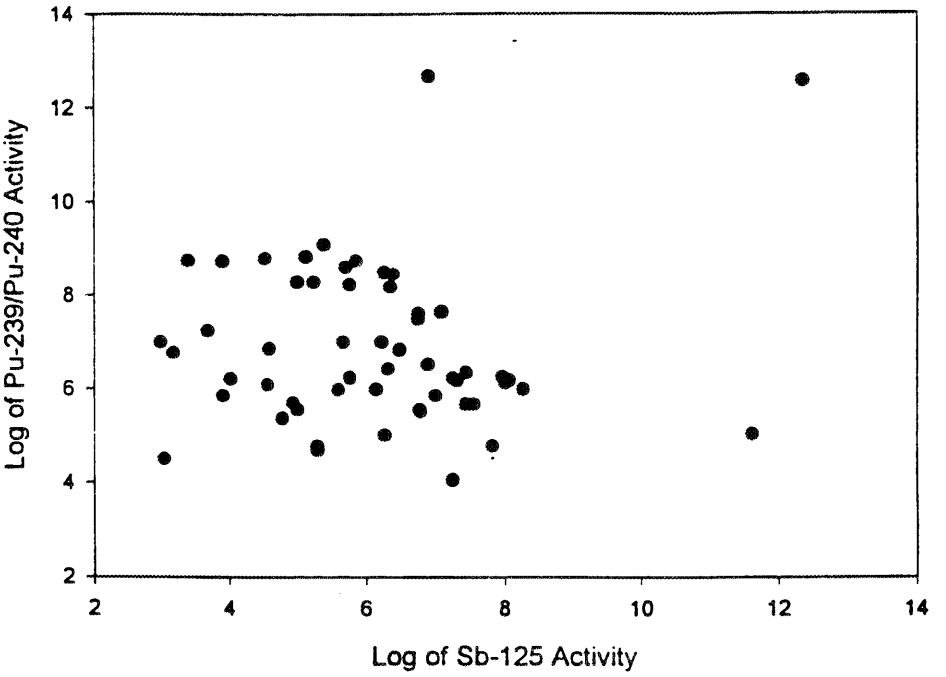
Correlation between Cm-244 and Sb-125 Activity



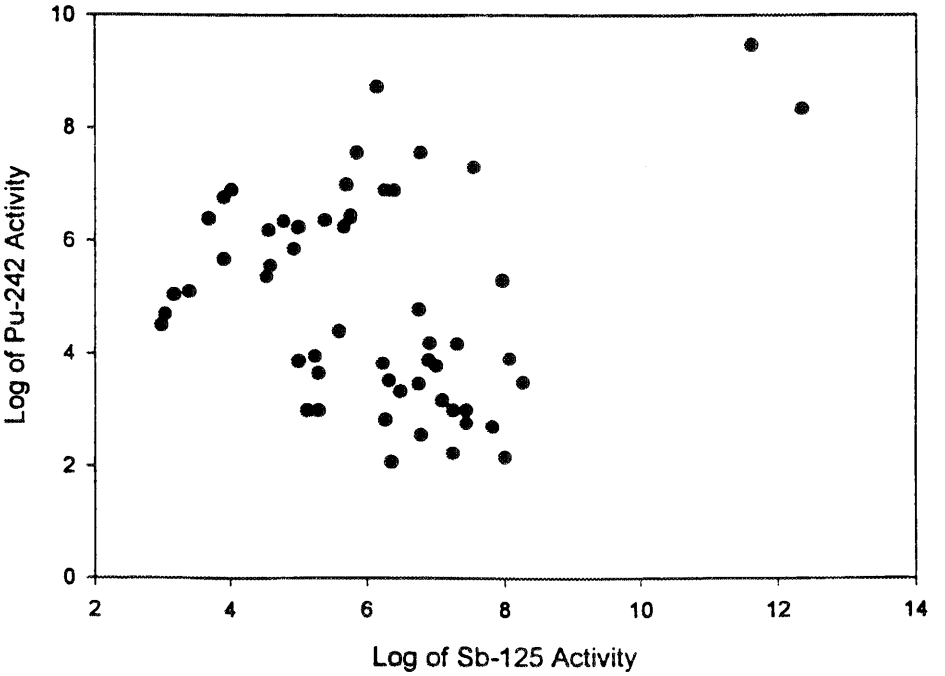
Correlation between Pu-238 and Sb-125 Activity

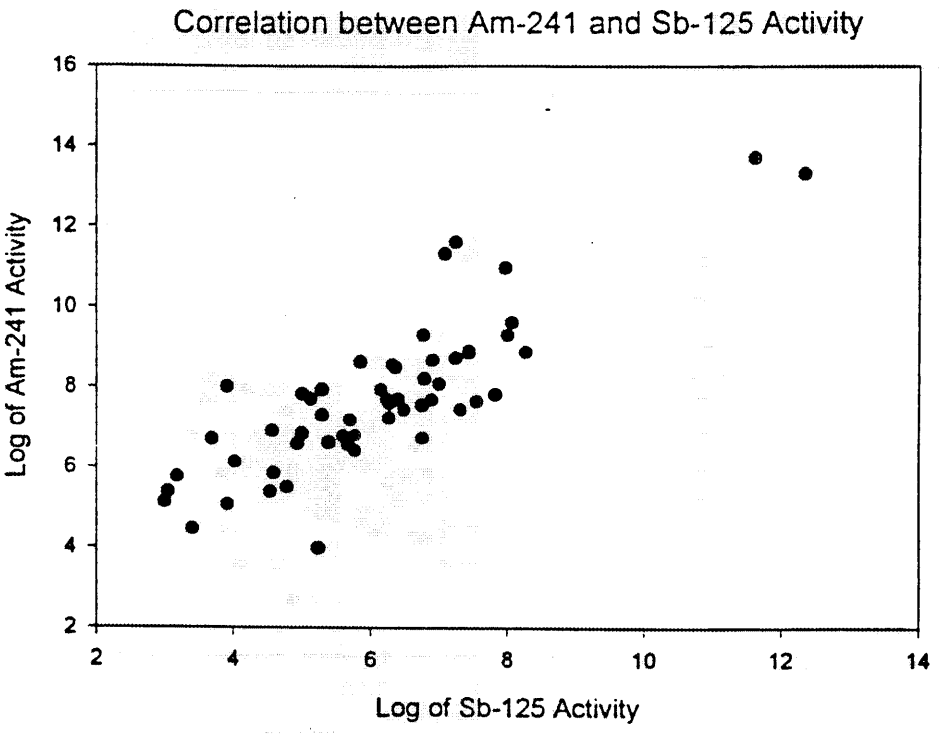


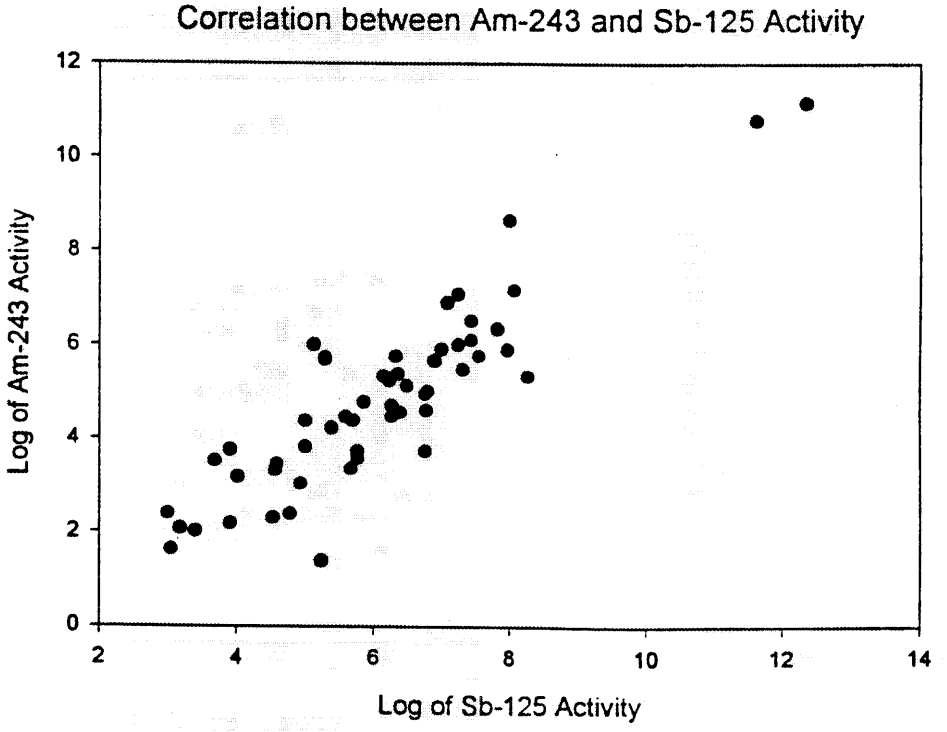
Correlation between Pu-239/Pu-240 and Sb-125 Activity



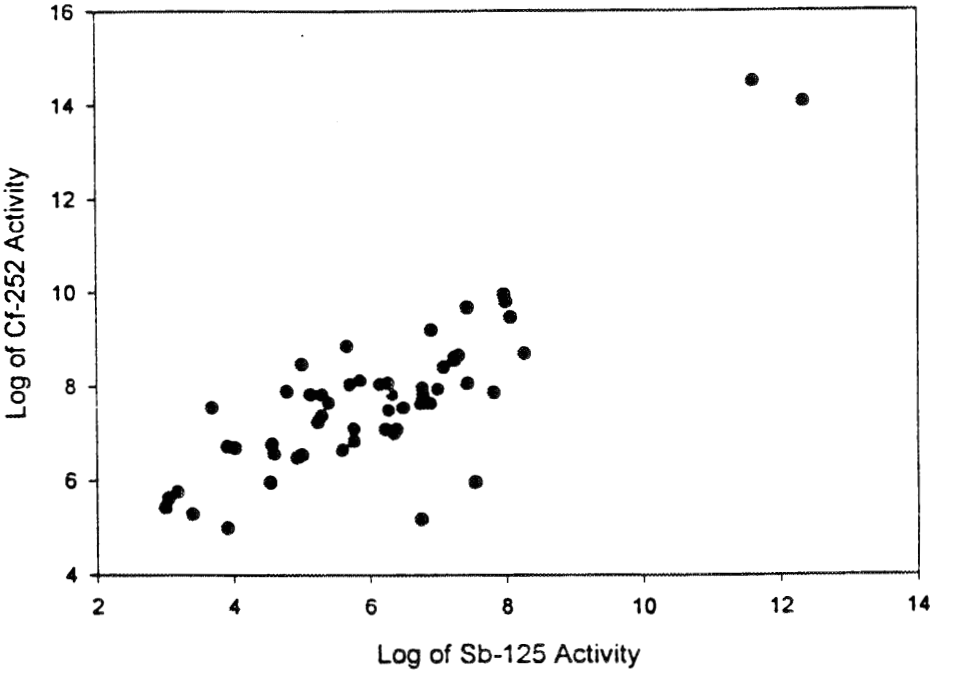
Correlation between Pu-242 and Sb-125 Activity



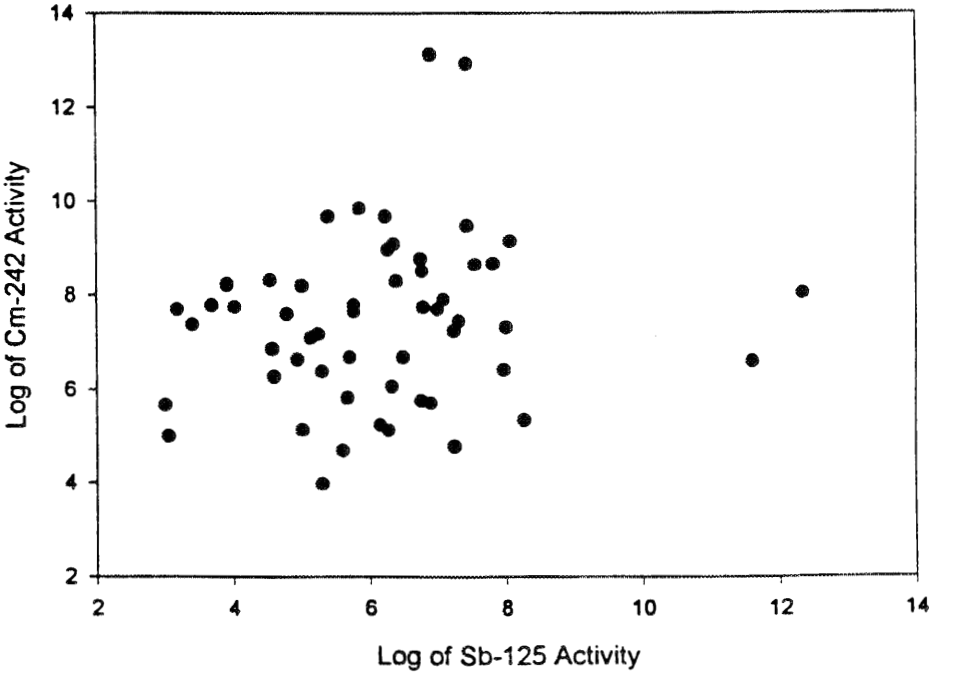

Correlation between Am-241 and Sb-125 Activity
Log of Am-241 Activity
Log of Sb-125 Activity
16
14
12
10
8
6
4
2
2
4
6
8
10
12
14


Correlation between Am-243 and Sb-125 Activity
Log of Am-243 Activity
Log of Sb-125 Activity
12
10
8
6
4
2
0
2
4
6
8
10
12
14

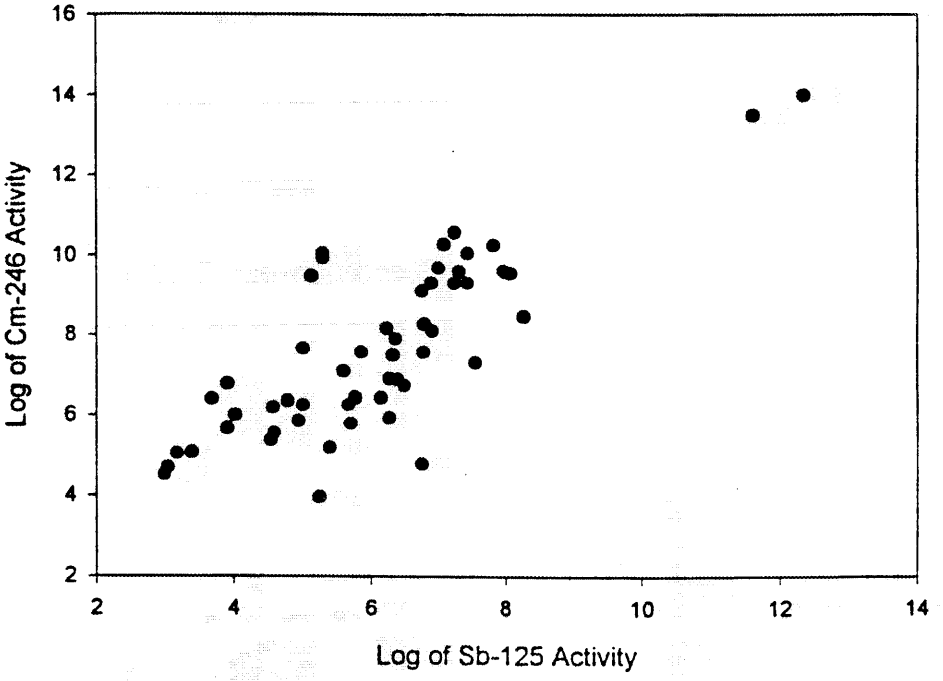
Correlation between Cf-252 and Sb-125 Activity

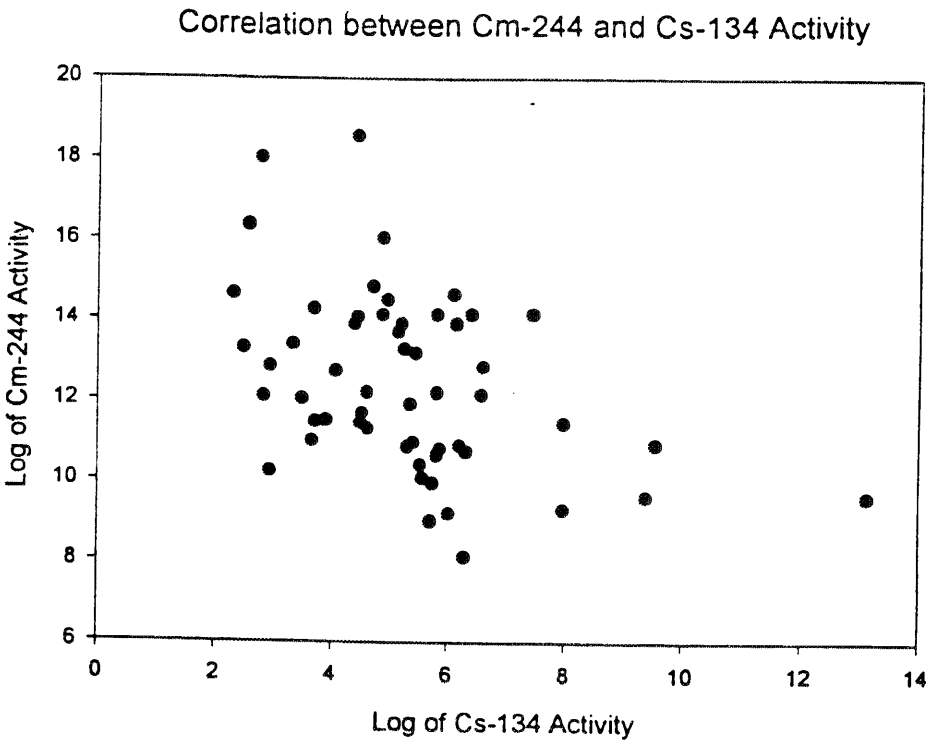


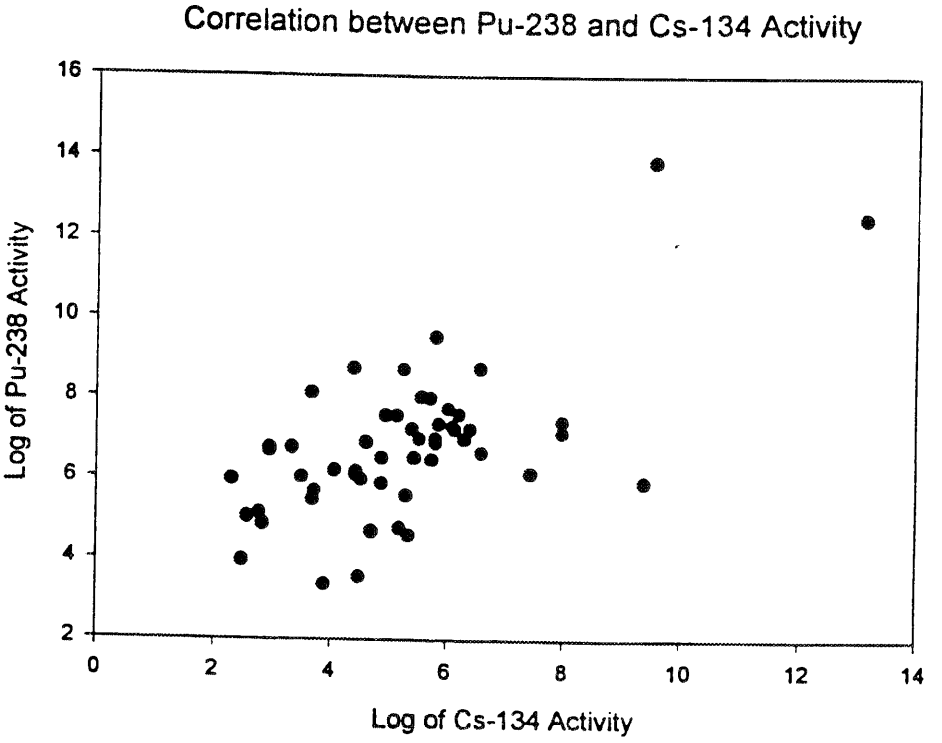
Correlation between Cm-242 and Sb-125 Activity

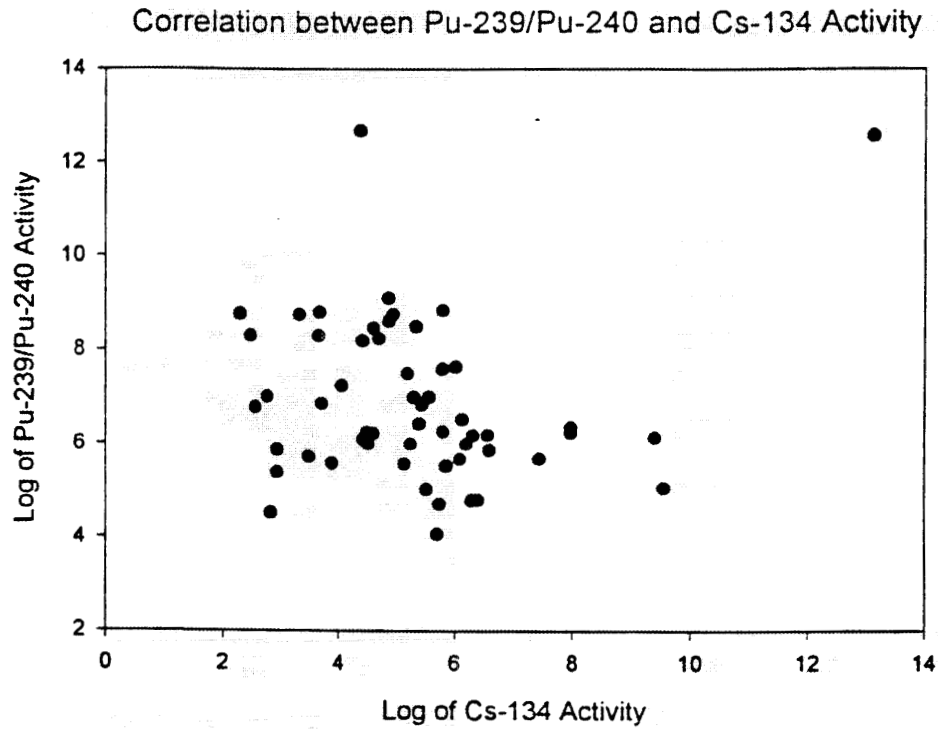


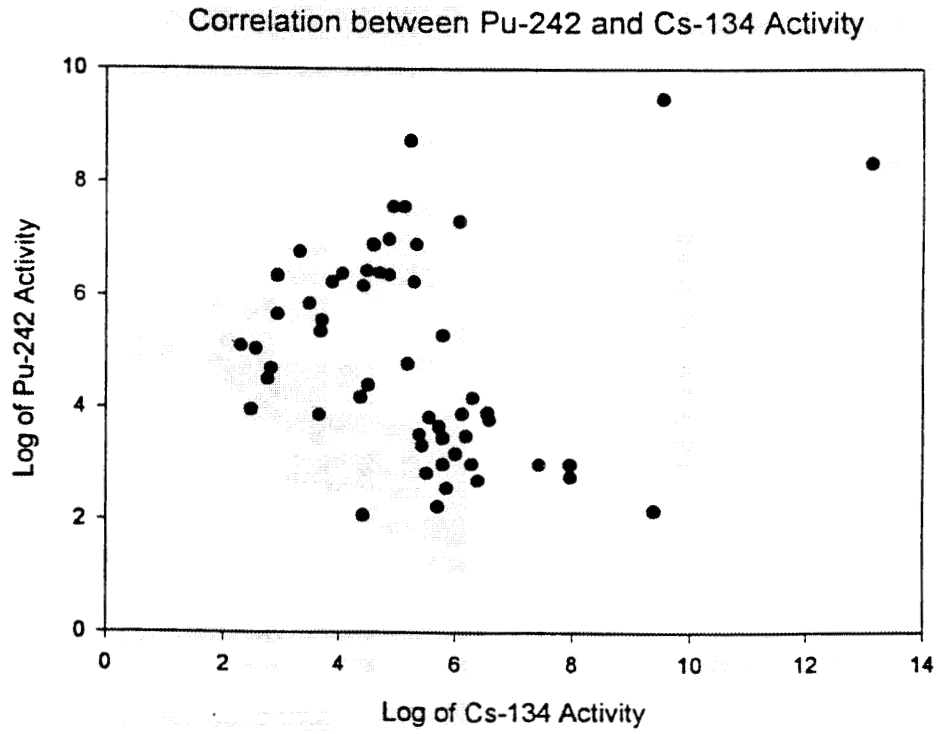
Correlation between Cm-246 and Sb-125 Activity



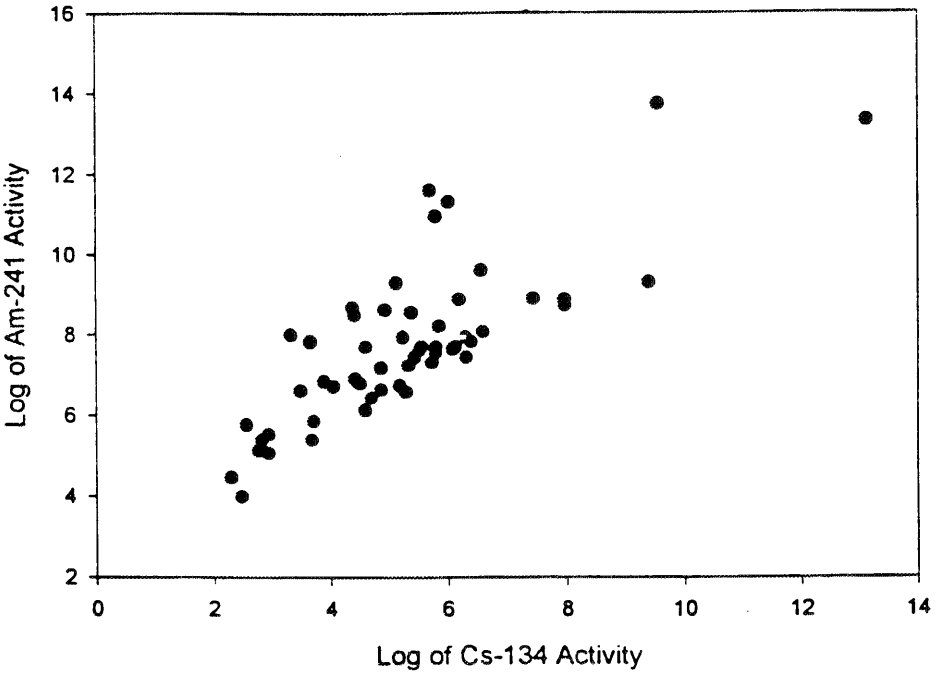

Correlation between Cm-244 and Cs-134 Activity
Log of Cm-244 Activity
Log of Cs-134 Activity
20
18
16
14
12
10
8
6
0
2
4
6
8
10
12
14


Correlation between Pu-238 and Cs-134 Activity
Log of Pu-238 Activity
Log of Cs-134 Activity
16
14
12
10
8
6
4
2
0
2
4
6
8
10
12
14

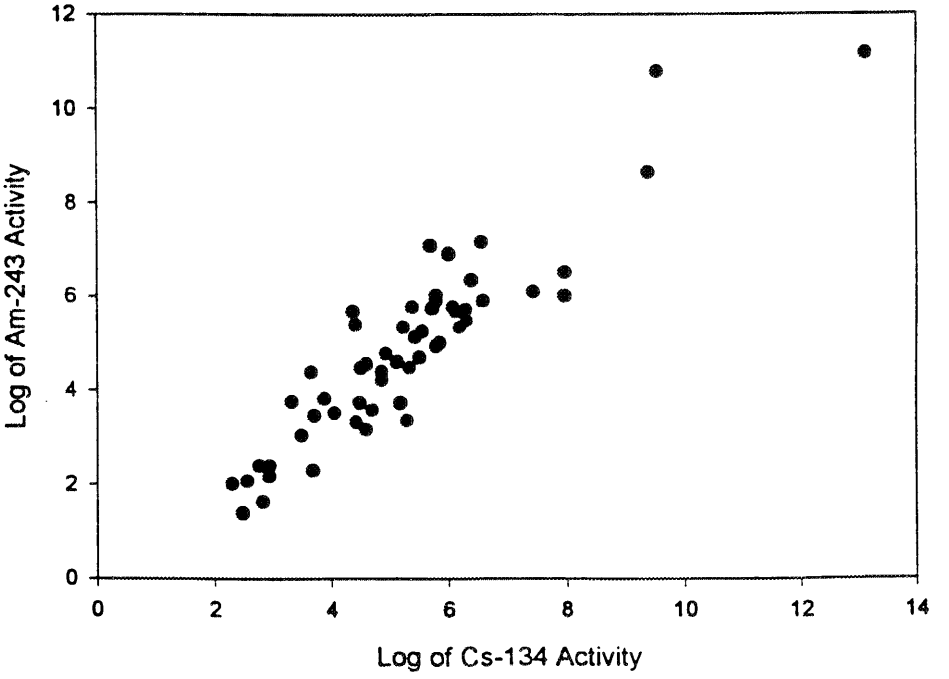

Correlation between Pu-239/Pu-240 and Cs-134 Activity
Log of Pu-239/Pu-240 Activity
Log of Cs-134 Activity
14
12
10
8
6
4
2
0
2
4
6
8
10
12
14

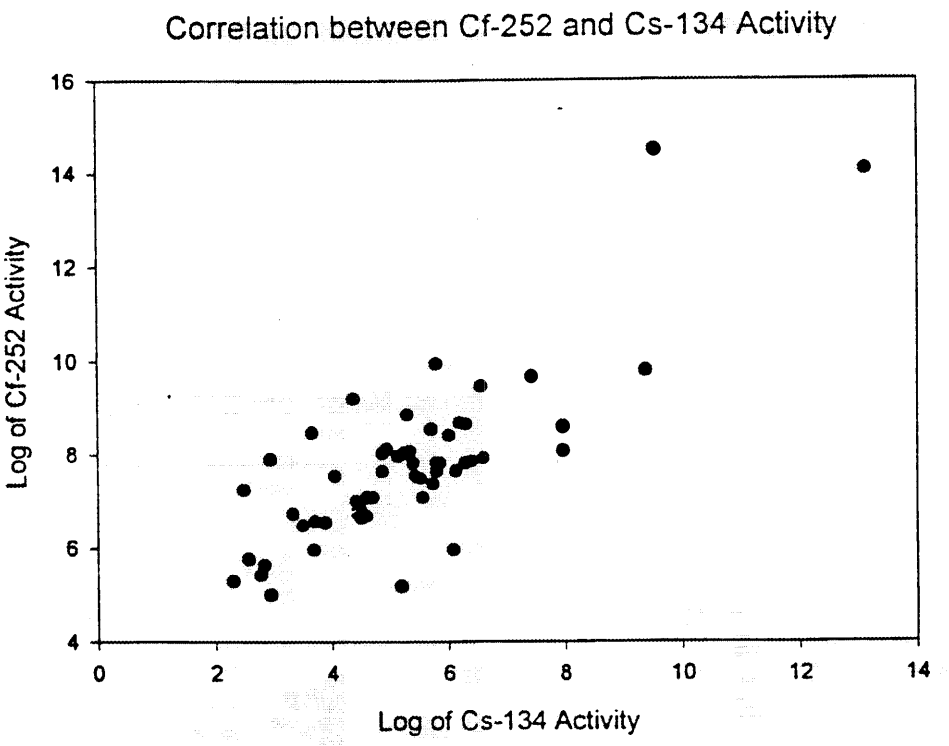

Correlation between Pu-242 and Cs-134 Activity
Log of Pu-242 Activity
Log of Cs-134 Activity
10
8
6
4
2
0
0
2
4
6
8
10
12
14

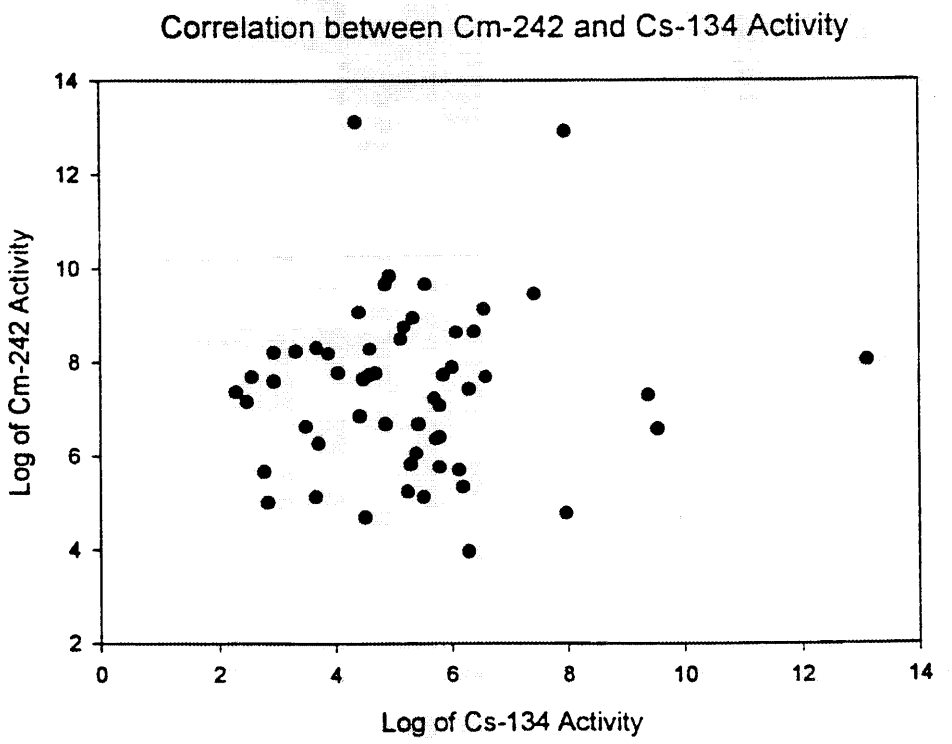
Correlation between Am-241 and Cs-134

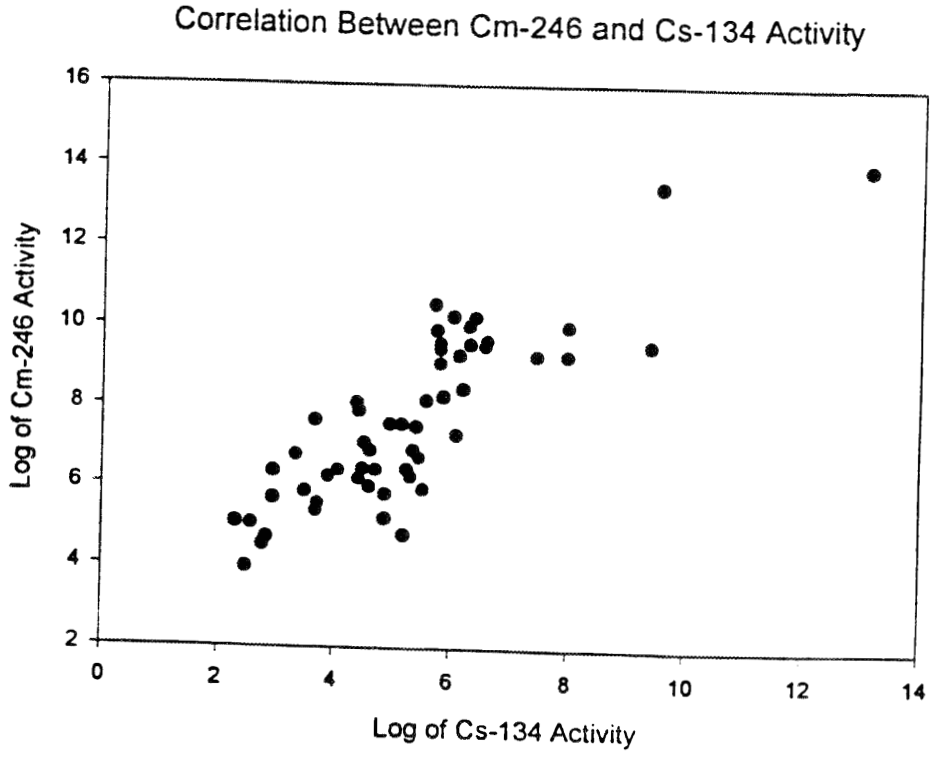


Correlation between Am-243 and Cs-134




Correlation between Cf-252 and Cs-134 Activity
Log of Cf-252 Activity
Log of Cs-134 Activity
16
14
12
10
8
6
4
0
2
4
6
8
10
12
14


Correlation between Cm-242 and Cs-134 Activity
Log of Cm-242 Activity
Log of Cs-134 Activity
14
12
10
8
6
4
2
0
2
4
6
8
10
12
14


Correlation Between Cm-246 and Cs-134 Activity
Log of Cm-246 Activity
Log of Cs-134 Activity
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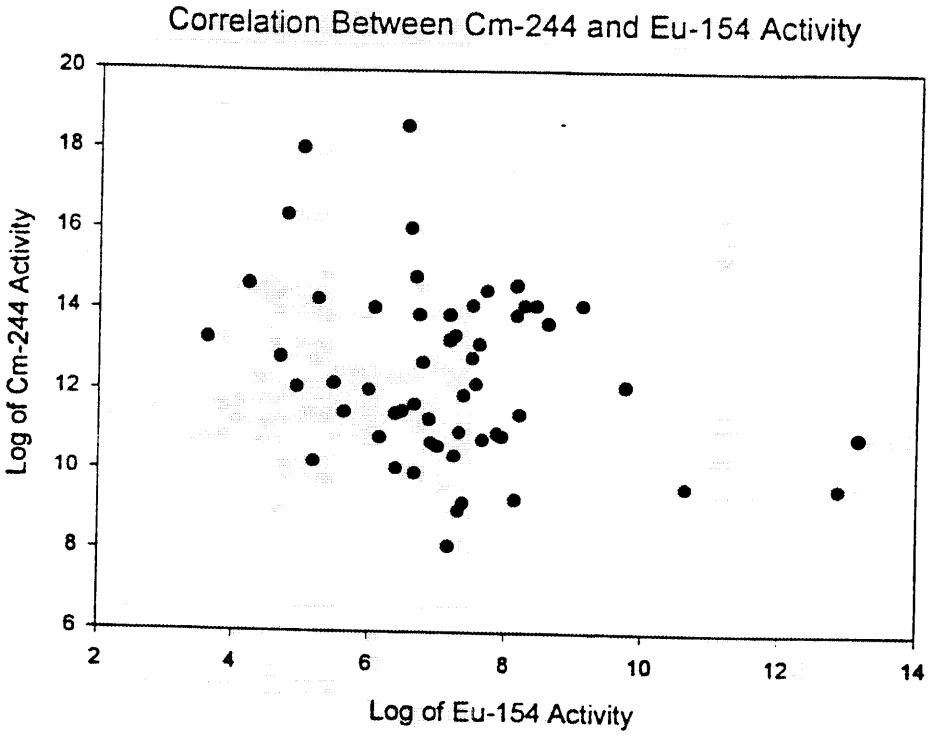
Correlation Between Cm-244 and Eu-154 Activity
Log of Cm-244 Activity
Log of Eu-154 Activity
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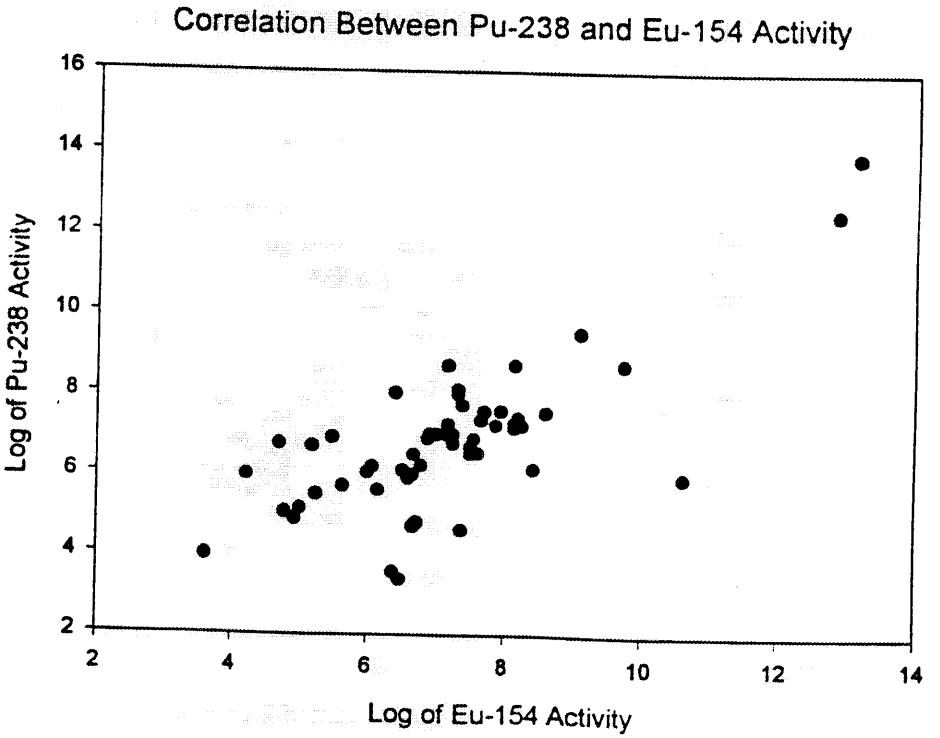
Correlation Between Pu-238 and Eu-154 Activity
Log of Pu-238 Activity
Log of Eu-154 Activity
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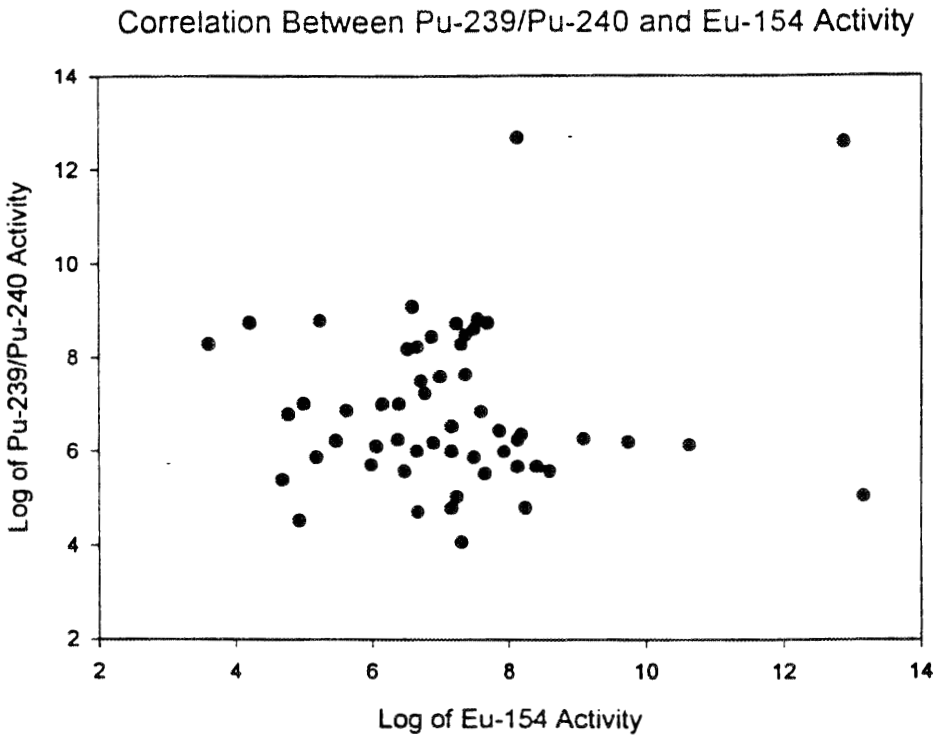
Correlation Between Pu-239/Pu-240 and Eu-154 Activity
Log of Pu-239/Pu-240 Activity
Log of Eu-154 Activity
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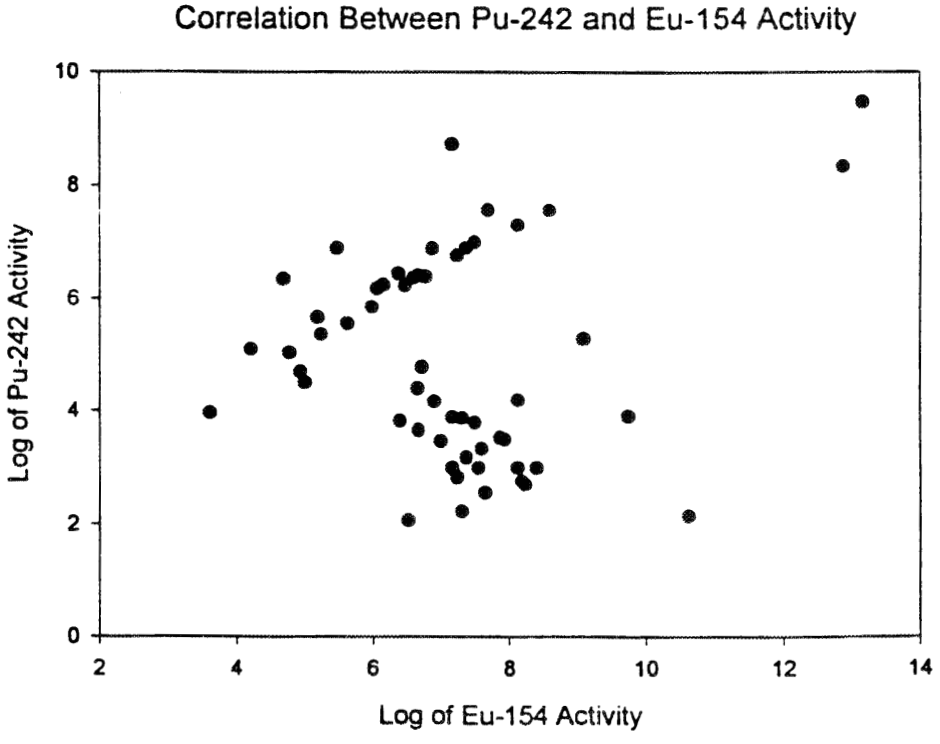
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Log of Pu-242 Activity
Log of Eu-154 Activity
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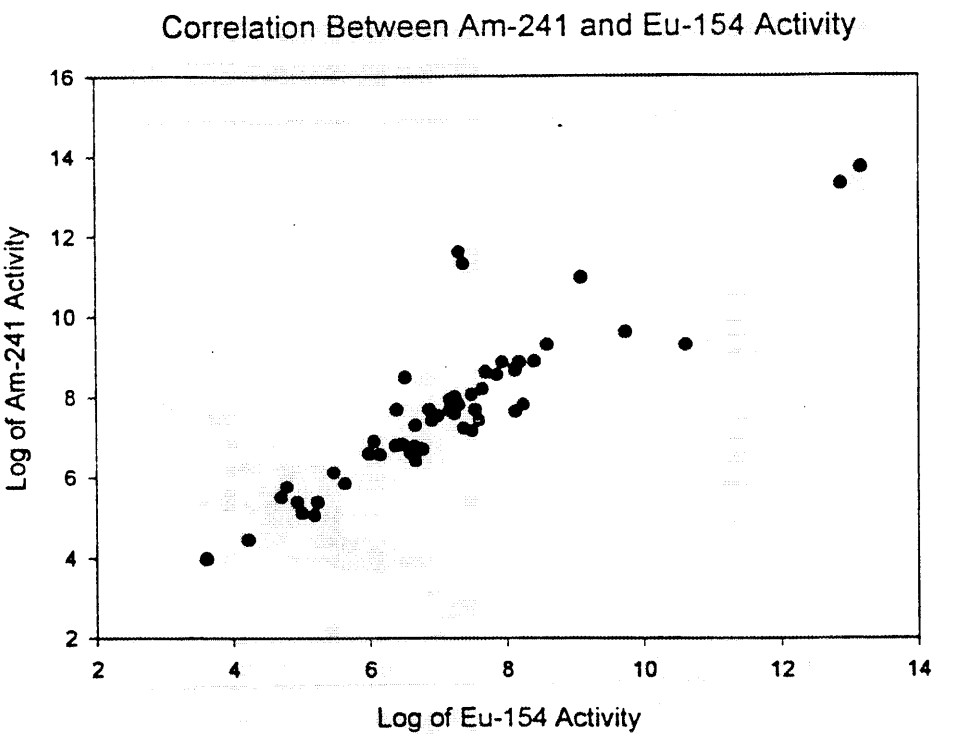
Correlation Between Am-241 and Eu-154 Activity
Log of Am-241 Activity
Log of Eu-154 Activity
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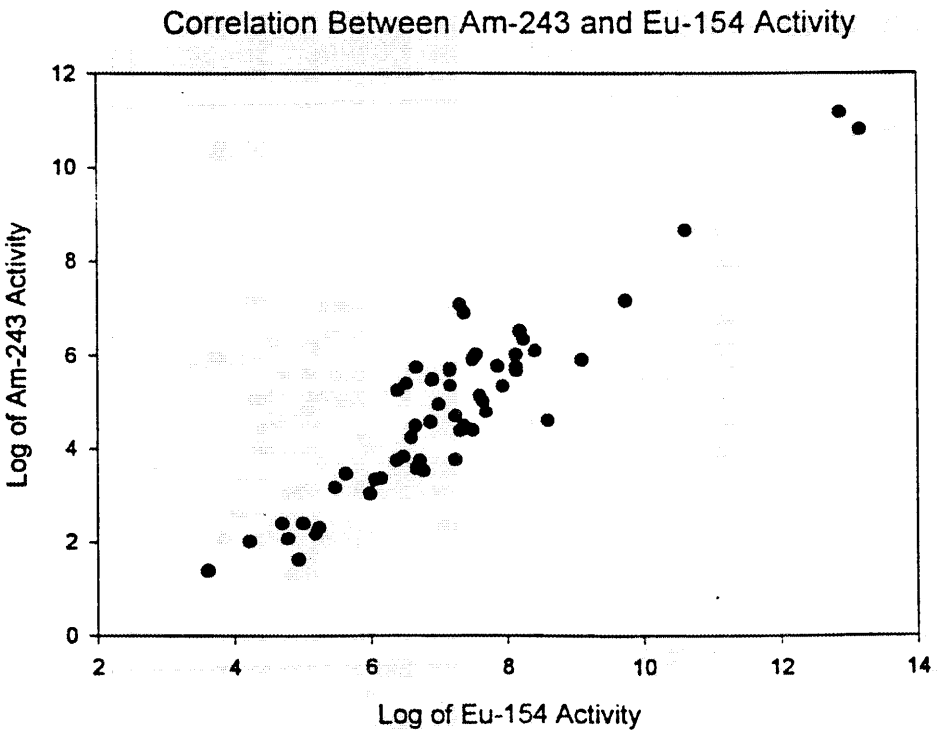
Correlation Between Am-243 and Eu-154 Activity
Log of Am-243 Activity
Log of Eu-154 Activity
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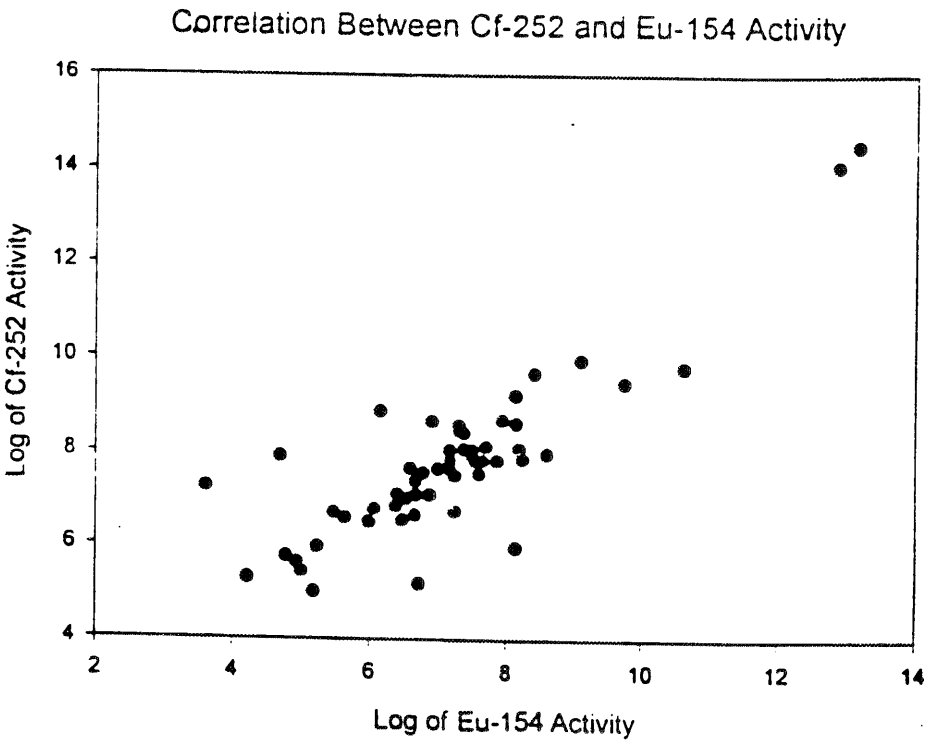
Correlation Between Cf-252 and Eu-154 Activity
Log of Cf-252 Activity
Log of Eu-154 Activity
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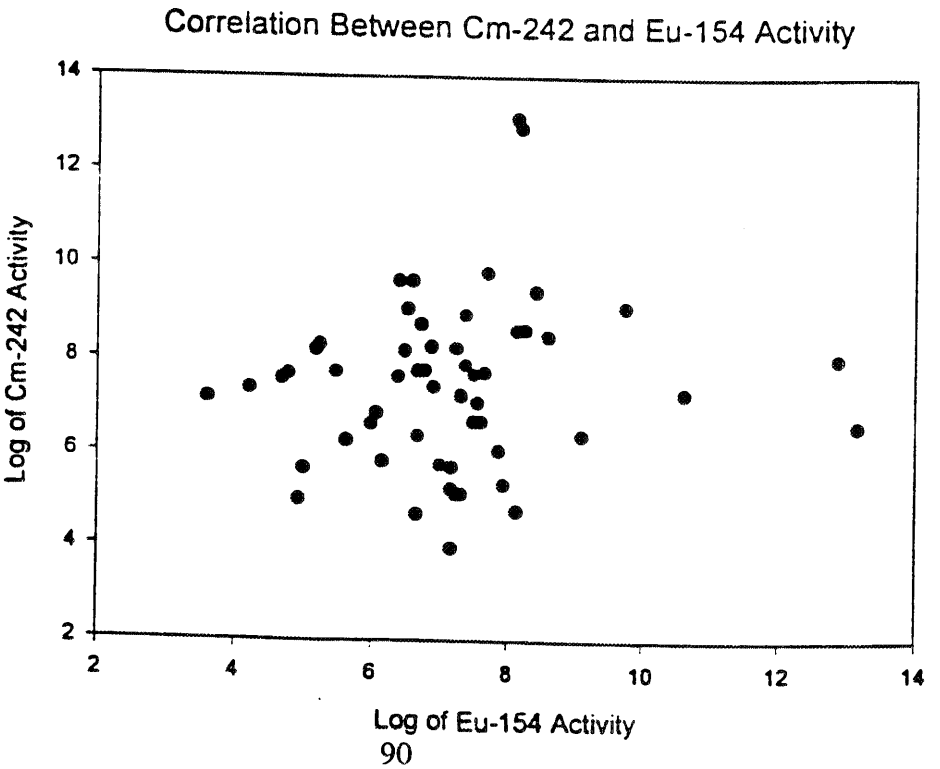
Correlation Between Cm-242 and Eu-154 Activity
Log of Cm-242 Activity
Log of Eu-154 Activity
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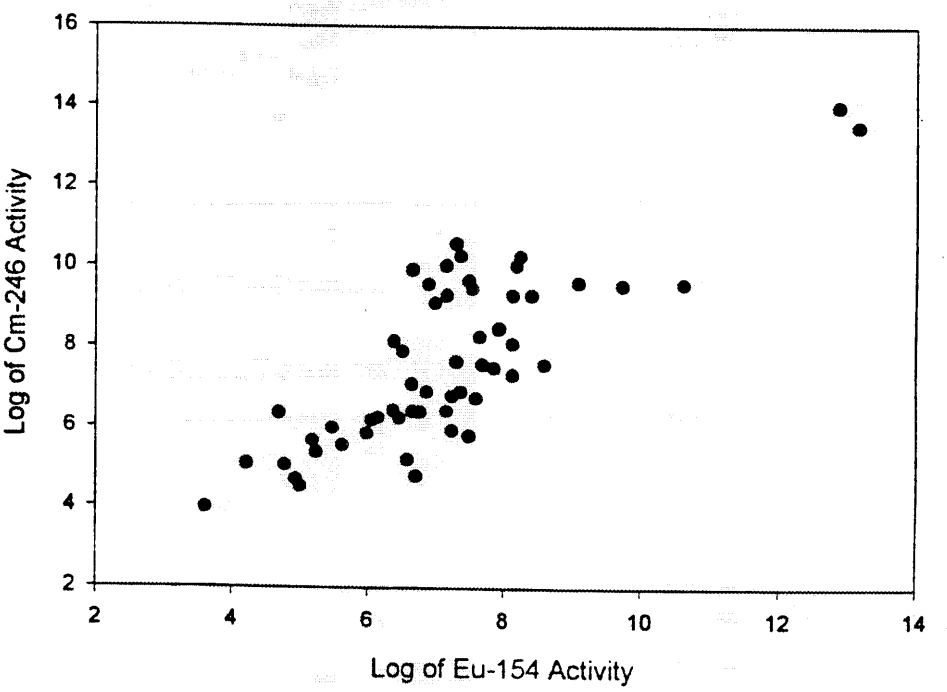
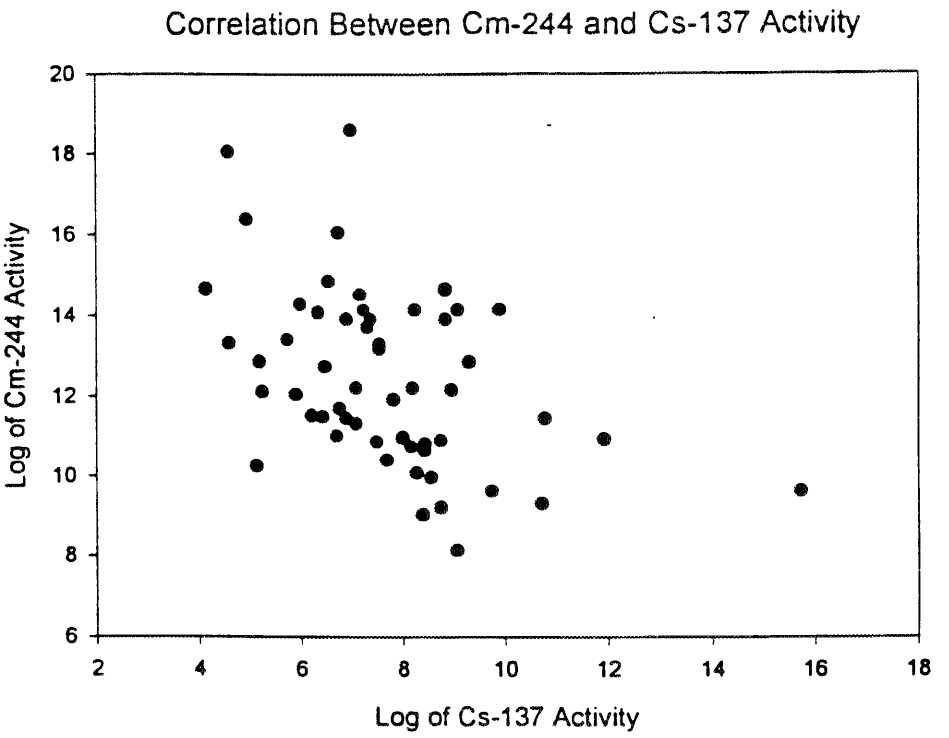
Correlation Between Cm-246 and Eu-154 Activity




Correlation Between Cm-244 and Cs-137 Activity
Log of Cm-244 Activity
Log of Cs-137 Activity
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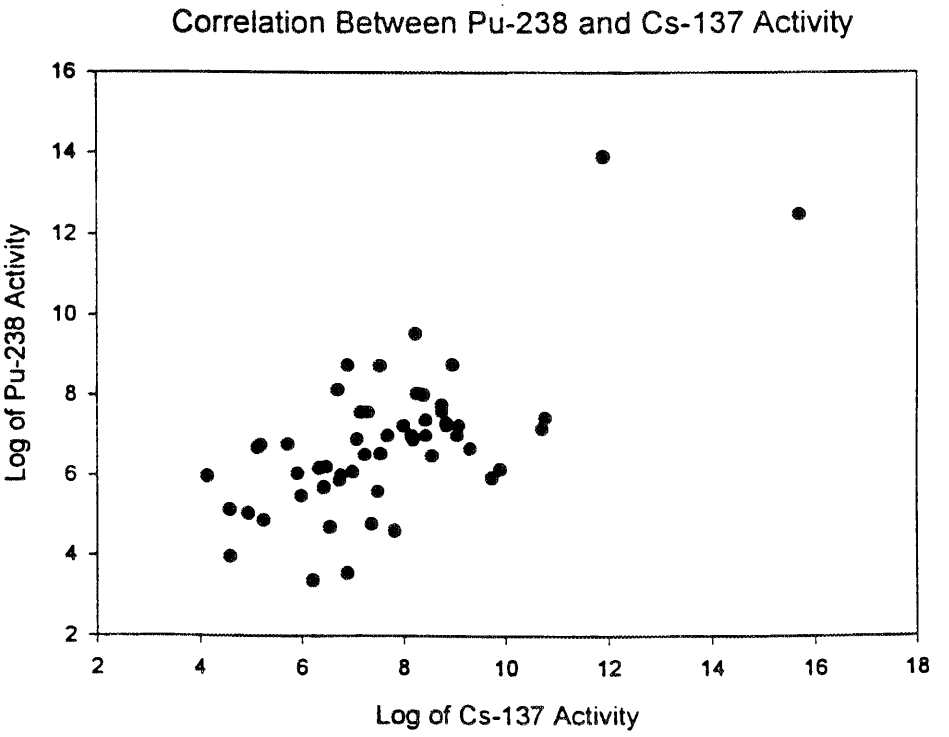
Correlation Between Pu-238 and Cs-137 Activity
Log of Pu-238 Activity
Log of Cs-137 Activity
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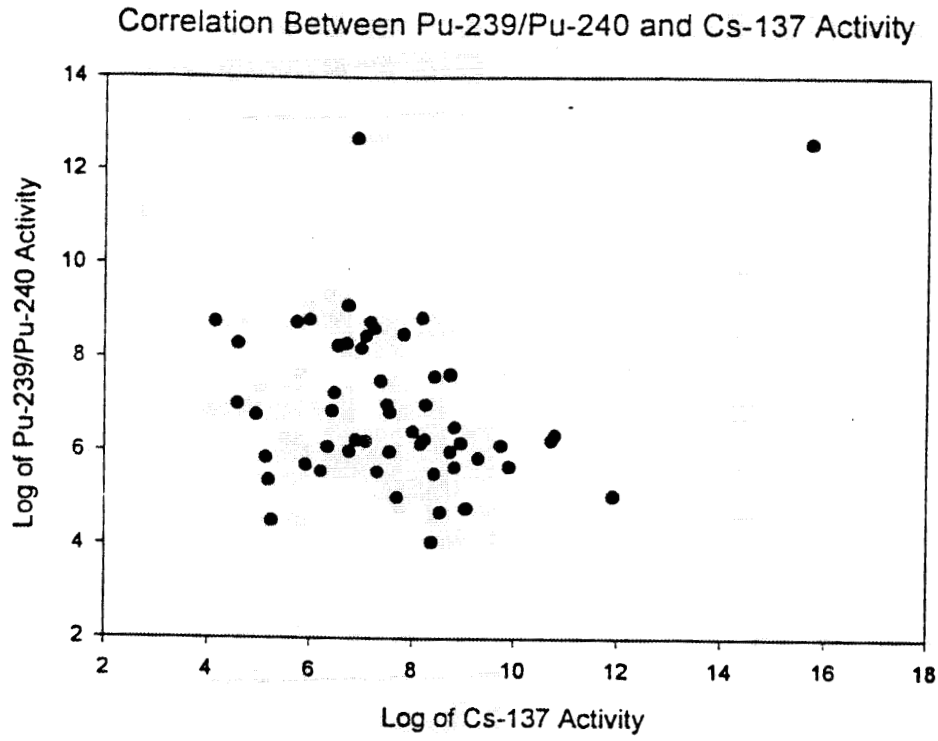
Correlation Between Pu-239/Pu-240 and Cs-137 Activity
Log of Pu-239/Pu-240 Activity
Log of Cs-137 Activity
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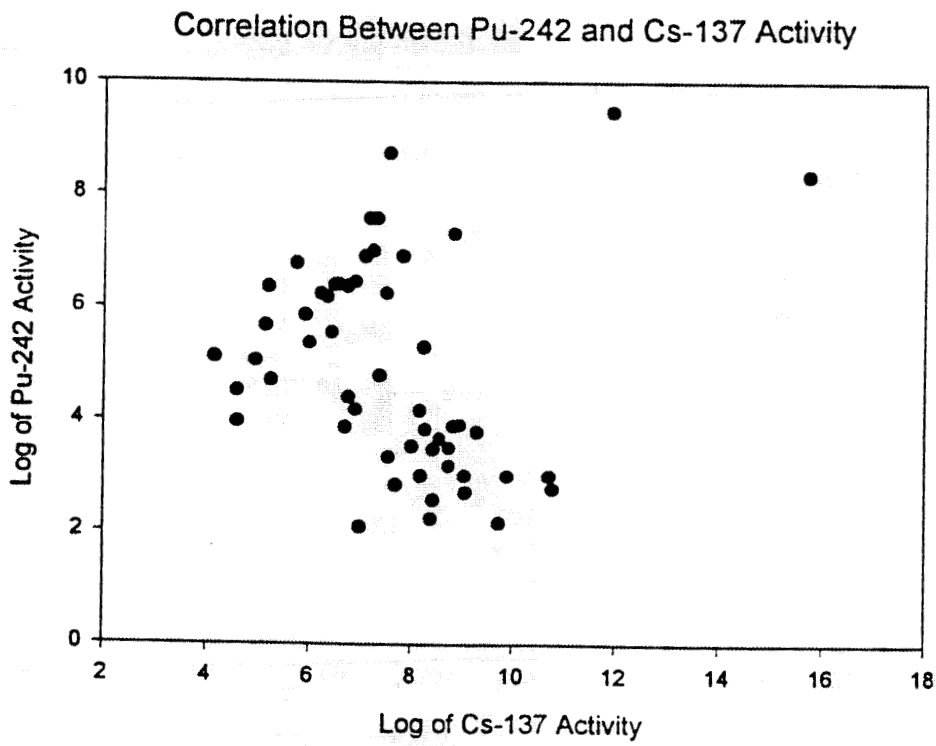
Correlation Between Pu-242 and Cs-137 Activity
Log of Pu-242 Activity
Log of Cs-137 Activity
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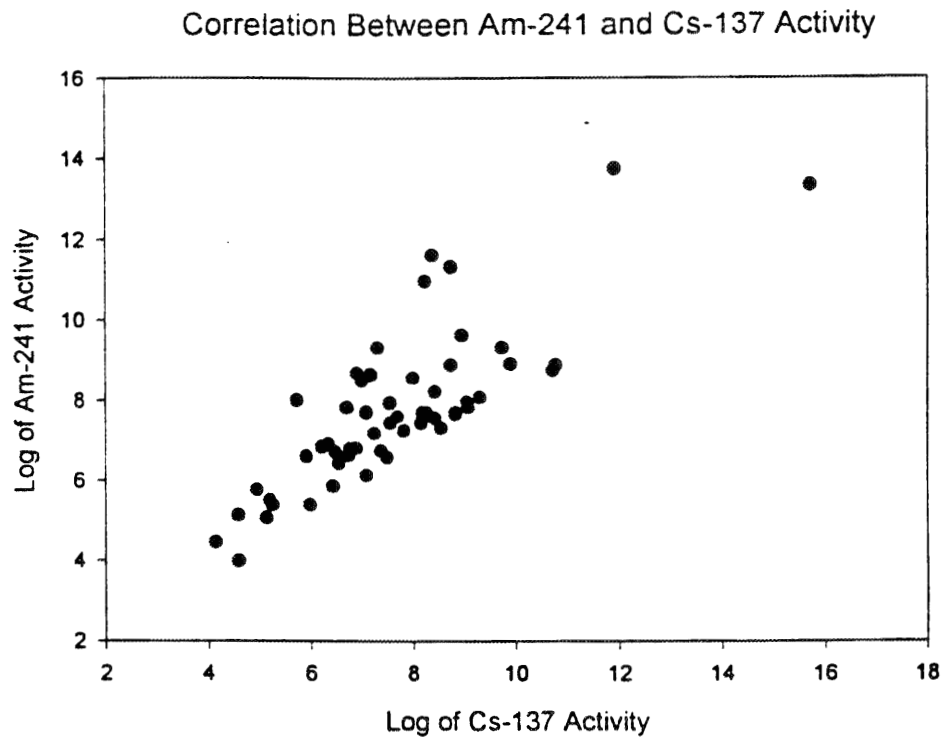
Correlation Between Am-241 and Cs-137 Activity
Log of Am-241 Activity
Log of Cs-137 Activity
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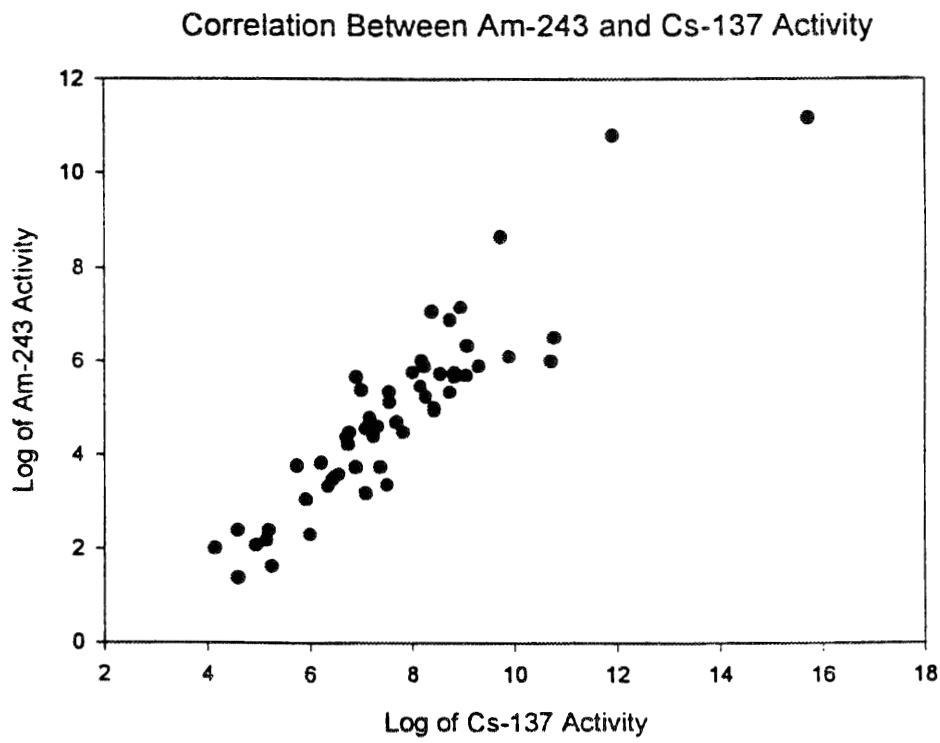
Correlation Between Am-243 and Cs-137 Activity
Log of Am-243 Activity
Log of Cs-137 Activity
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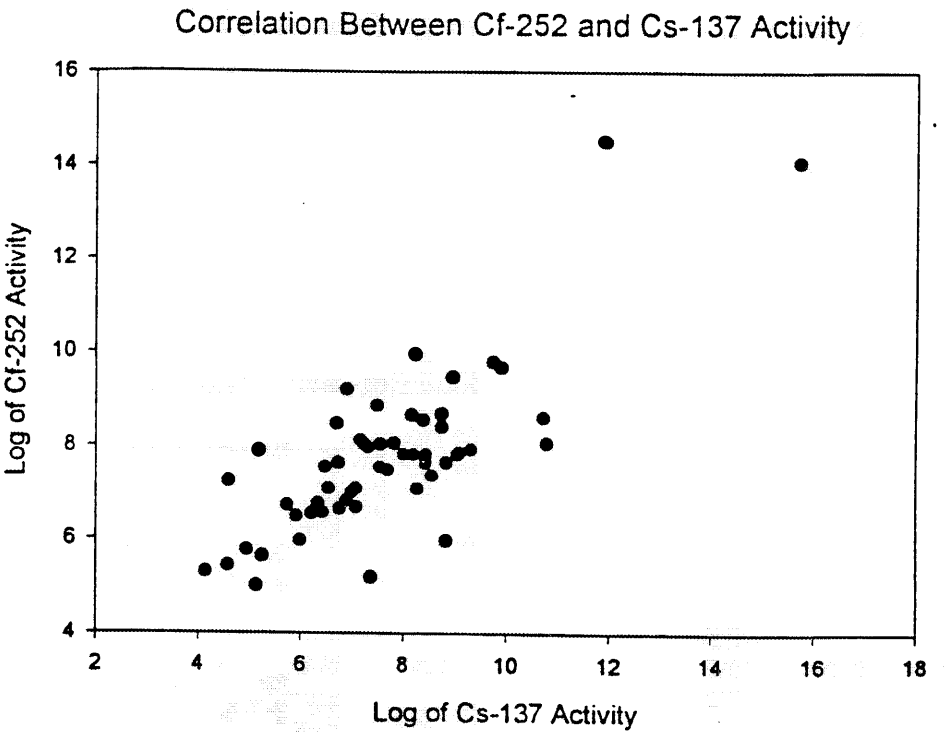
Correlation Between Cf-252 and Cs-137 Activity
Log of Cf-252 Activity
Log of Cs-137 Activity
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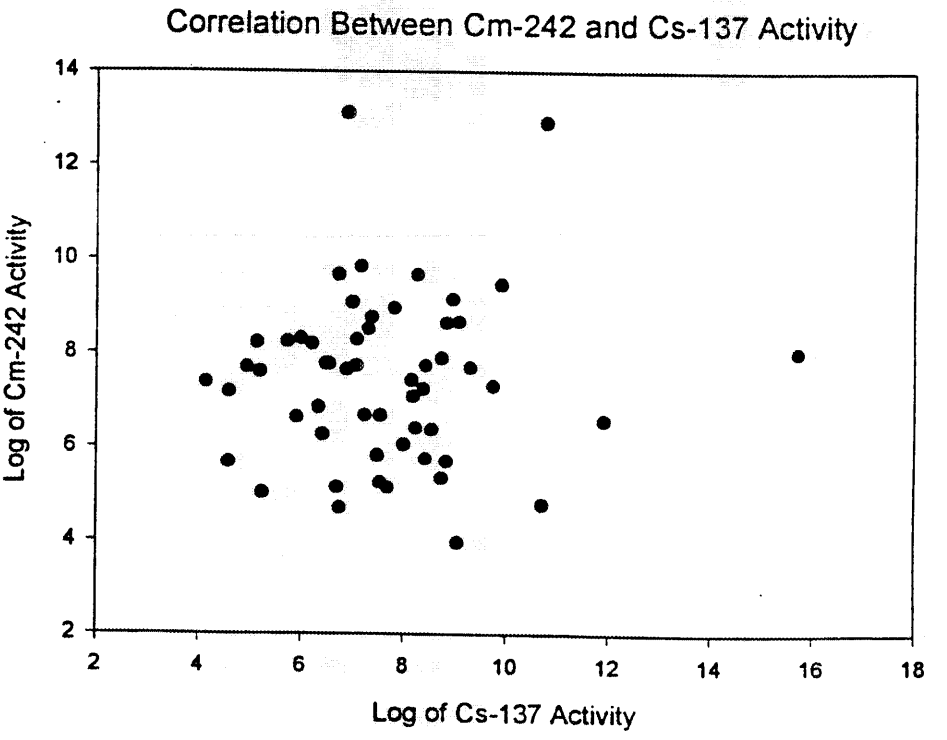
Correlation Between Cm-242 and Cs-137 Activity
Log of Cm-242 Activity
Log of Cs-137 Activity
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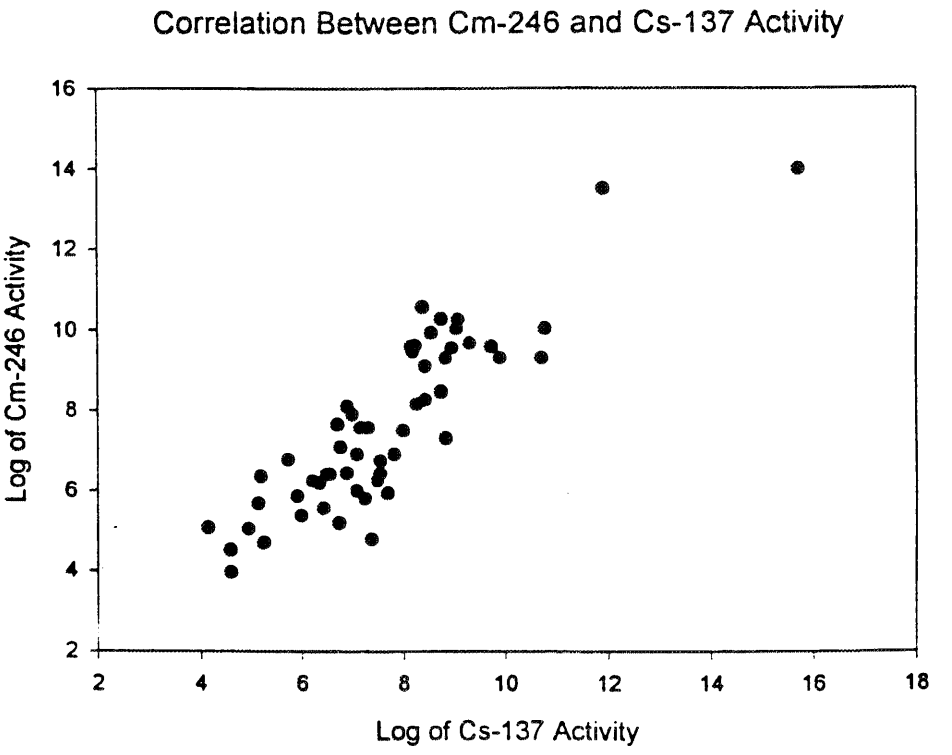
Correlation Between Cm-246 and Cs-137 Activity
Log of Cm-246 Activity
Log of Cs-137 Activity
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APPENDIX C
Alpha / gamma activity ratios calculated for melted polyethylene bucket 6120

C1. Activity ratios of alpha emitting radionuclides and Ru-106

Cm244/Ru106

Sample ID	Waste Component	Waste Group	Cm244 (Bq/total)	Ru106 (Bq/total)	Cm244/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-1	bottle	Glass	1.40E+06	6.20E+05	2.258	1	0.909	0.815
LN-11	bottle	Glass	1.10E+04	4.70E+03	2.340	1	2.727	0.850
LN-13	bottle	Glass	3.40E+03	1.30E+03	2.615	1	4.545	0.961
LN-15	tool	Metal	1.10E+06	5.60E+04	19.643	1	6.364	2.978
LN-19	bottle	Glass	4.20E+04	1.90E+03	22.105	1	8.182	3.096
LN-25	bottle	Glass	1.20E+08	5.20E+06	23.077	1	10.000	3.139
LN-26	bottle	Glass	4.60E+04	1.80E+03	25.556	1	11.818	3.241
LN-28	bottle	Glass	1.10E+06	2.20E+04	50.000	1	13.636	3.912
LN-3	bottle	Glass	1.40E+06	2.70E+04	51.852	1	15.455	3.948
LN-33	valve	Poly	1.90E+05	3.30E+03	57.576	1	17.273	4.053
LN-35	bottle	Poly	1.40E+06	2.10E+04	66.667	1	19.091	4.200
LN-36	cell	Metal	1.00E+04	1.50E+02	66.667	1	20.909	4.200
LN-38	tool	Metal	5.30E+05	7.30E+03	72.603	1	22.727	4.285
LN-39	cell	Metal	8.30E+03	1.10E+02	75.455	1	24.545	4.324
LN-4	bottle	Glass	2.00E+05	2.60E+03	76.923	1	26.364	4.343
LN-40	hose	Poly	1.50E+04	1.90E+02	78.947	1	28.182	4.369
LN-41	column	Metal	5.40E+04	5.70E+02	94.737	1	30.000	4.551
LN-44	cap	Metal	2.40E+04	2.30E+02	104.348	1	31.818	4.648
LN-46	can	Metal	3.30E+04	3.10E+02	106.452	1	33.636	4.668
LN-48	tool	Metal	4.90E+04	4.50E+02	108.889	1	35.455	4.690
LN-49	socket	Metal	1.20E+05	1.10E+03	109.091	1	37.273	4.692
LN-54	case	Metal	5.80E+04	5.10E+02	113.725	1	39.091	4.734
LN-6	bottle	Glass	9.30E+04	7.60E+02	122.368	1	40.909	4.807
LN-7	tool	Metal	6.00E+04	4.90E+02	122.449	1	42.727	4.808
LN-8	bottle	Glass	3.80E+05	3.00E+03	126.667	1	44.545	4.842
LN-9	bulb	Glass	2.10E+04	1.60E+02	131.250	1	46.364	4.877
LN-GL	bottles	Glass	1.50E+04	1.00E+02	150.000	1	48.182	5.011
LN-ML	tool	Metal	5.50E+04	3.20E+02	171.875	1	50.000	5.147
RH9A	Melt	Poly	1.80E+05	9.80E+02	183.673	1	51.818	5.213
RH9AA	Melt	Poly	6.90E+07	3.70E+05	186.486	1	53.636	5.228
RH9C	Melt	Poly	1.70E+05	9.10E+02	186.813	1	55.455	5.230
RH9D	belt	Poly	1.30E+06	6.60E+03	196.970	1	57.273	5.283
RH9E	Valve	Poly	9.70E+04	4.60E+02	210.870	1	59.091	5.351
RH9EE	Valve	Poly	5.90E+05	2.60E+03	226.923	1	60.909	5.425
RH9F	Valve	Poly	2.00E+05	8.80E+02	227.273	1	62.727	5.426
RH9G	Valve	Poly	2.80E+04	1.20E+02	233.333	1	64.545	5.452
RH9H	Light Cord	Poly	1.00E+05	4.20E+02	238.095	1	66.364	5.473
RH9I	MSM Boot	Poly	9.40E+04	3.70E+02	254.054	1	68.182	5.538
RH9J	Lid	Poly	5.20E+04	1.80E+02	288.889	1	70.000	5.666
RH9K	Lid	Poly	1.40E+06	4.10E+03	341.463	1	71.818	5.833
RH9KK	Lid	Poly	3.80E+05	1.00E+03	380.000	1	73.636	5.940
RH9L	bottle	Glass	3.40E+05	7.80E+02	435.897	1	75.455	6.077
RH9LL	bottle	Glass	1.10E+06	2.30E+03	478.261	1	77.273	6.170
RH9M	bottle	Glass	1.50E+05	3.10E+02	483.871	1	79.091	6.182
RH9N	glassware	Glass	9.00E+05	1.70E+03	529.412	1	80.909	6.272
RH9O	housing	Glass	6.00E+05	1.10E+03	545.455	1	82.727	6.302
RH9P	Tool	Metal	8.20E+04	1.50E+02	546.667	1	84.545	6.304
RH9Q	Wire	Metal	6.60E+05	1.20E+03	550.000	1	86.364	6.310
RH9QQ	Wire	Metal	2.00E+06	2.30E+03	869.565	1	88.182	6.768
RH9R	Lid	Metal	1.60E+06	1.80E+03	888.889	1	90.000	6.790
RH9S	Wipes	Wipes	2.30E+06	1.90E+03	1,210.526	1	91.818	7.099
RH9SS	Wipes	Wipes	2.80E+06	2.20E+03	1,272.727	1	93.636	7.149
RH9T	Wipes	Wipes	2.30E+06	1.00E+03	2,300.000	1	95.455	7.741
RH9U	Wipes	Wipes	1.30E+07	2.20E+03	5,909.091	1	97.273	8.684
RH9V	Wipes	Wipes	9.40E+06	1.30E+03	7,230.769	1	99.091	8.886

Pu238/Ru106

Sample ID	Waste Component	Waste Group	Pu238 (Bq/total)	Ru106 (Bq/total)	Pu238/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	3.80E+02	6.20E+05	0.001	1	0.909	-7.397
LN-1	bottle	Glass	4.70E+02	5.60E+04	0.008	1	2.727	-4.780
RH9LL	bottle	Glass	1.20E+02	4.70E+03	0.026	1	4.545	-3.668
RH9O	housing	Glass	5.25E+01	1.30E+03	0.040	1	6.364	-3.209
LN-GL	bottles	Glass	2.70E+05	5.20E+06	0.052	1	8.182	-2.958
LN-26	bottle	Glass	1.10E+03	2.10E+04	0.052	1	10.000	-2.949
LN-11	bottle	Glass	1.30E+03	2.20E+04	0.059	1	11.818	-2.829
RH9H	Light Cord	Poly	2.90E+01	4.50E+02	0.064	1	13.636	-2.742
RH9I	MSM Boot	Poly	3.50E+01	4.90E+02	0.071	1	15.455	-2.639
RH9M	bottle	Glass	1.00E+02	7.60E+02	0.132	1	17.273	-2.028
RH9J	Lid	Poly	2.70E+02	1.90E+03	0.142	1	19.091	-1.951
LN-4	bottle	Glass	9.80E+02	6.60E+03	0.148	1	20.909	-1.907
RH9SS	Wipes	Wipes	1.10E+02	5.10E+02	0.216	1	22.727	-1.534
LN-33	valve	Poly	6.40E+03	2.70E+04	0.237	1	24.545	-1.440
LN-38	tool	Metal	6.90E+02	2.60E+03	0.265	1	26.364	-1.327
RH9D	bckt	Poly	4.85E+02	1.80E+03	0.269	1	28.182	-1.311
LN-41	column	Metal	2.00E+03	7.30E+03	0.274	1	30.000	-1.295
LN-9	bulb	Glass	6.60E+02	2.30E+03	0.287	1	31.818	-1.248
LN-46	can	Metal	1.10E+03	3.30E+03	0.333	1	33.636	-1.099
LN-49	socket	Metal	4.00E+02	1.10E+03	0.364	1	35.455	-1.012
LN-25	bottle	Glass	4.40E+02	1.20E+03	0.367	1	37.273	-1.003
LN-8	bottle	Glass	7.90E+02	1.80E+03	0.439	1	39.091	-0.824
LN-48	tool	Metal	1.60E+03	3.00E+03	0.533	1	40.909	-0.629
LN-54	case	Metal	1.40E+03	2.60E+03	0.538	1	42.727	-0.619
LN-28	bottle	Glass	1.40E+03	2.30E+03	0.609	1	44.545	-0.496
RH9V	Wipes	Wipes	3.60E+02	5.70E+02	0.632	1	46.364	-0.460
LN-3	bottle	Glass	1.40E+03	2.20E+03	0.636	1	48.182	-0.452
LN-19	bottle	Glass	1.10E+03	1.70E+03	0.647	1	50.000	-0.435
RH9U	Wipes	Wipes	1.55E+02	1.90E+02	0.816	1	51.818	-0.204
RH9A	Melt	Poly	1.30E+02	1.50E+02	0.867	1	53.636	-0.143
LN-6	bottle	Glass	1.70E+03	1.90E+03	0.895	1	55.455	-0.111
LN-13	bottle	Glass	1.10E+03	1.00E+03	1.100	1	57.273	0.095
RH9E	Valve	Poly	3.00E+02	2.30E+02	1.304	1	59.091	0.266
RH9C	Melt	Poly	4.20E+02	3.10E+02	1.355	1	60.909	0.304
LN-39	cell	Metal	3.00E+03	2.20E+03	1.364	1	62.727	0.310
RH9R	Lid	Metal	2.40E+02	1.60E+02	1.500	1	64.545	0.405
RH9AA	Melt	Poly	1.70E+02	1.10E+02	1.545	1	66.364	0.435
RH9L	bottle	Glass	5.00E+02	3.20E+02	1.563	1	68.182	0.446
RH9K	Lid	Poly	6.80E+02	4.20E+02	1.619	1	70.000	0.482
LN-36	cell	Metal	2.30E+03	1.30E+03	1.769	1	71.818	0.571
RH9QQ	Wire	Metal	1.95E+03	9.80E+02	1.990	1	73.636	0.688
RH9N	glassware	Glass	1.95E+03	9.10E+02	2.143	1	75.455	0.762
RH9F	Valve	Poly	1.00E+03	4.60E+02	2.174	1	77.273	0.777
RH9P	Tool	Metal	9.90E+02	3.70E+02	2.676	1	79.091	0.984
LN-ML	tool	Metal	1.10E+06	3.70E+05	2.973	1	80.909	1.090
LN-35	bottle	Poly	1.40E+04	4.10E+03	3.415	1	82.727	1.228
LN-7	tool	Metal	3.40E+03	8.80E+02	3.864	1	84.545	1.352
RH9T	Wipes	Wipes	3.90E+02	1.00E+02	3.900	1	86.364	1.361
LN-44	cap	Metal	3.10E+03	7.80E+02	3.974	1	88.182	1.380
RH9KK	Lid	Poly	8.50E+02	1.80E+02	4.722	1	90.000	1.552
RH9S	Wipes	Wipes	1.50E+03	3.10E+02	4.839	1	91.818	1.577
RH9EE	Valve	Poly	6.20E+03	1.10E+03	5.636	1	93.636	1.729
RH9Q	Wire	Metal	8.75E+02	1.50E+02	5.833	1	95.455	1.764
LN-15	tool	Metal	6.30E+03	1.00E+03	6.300	1	97.273	1.841
RH9G	Valve	Poly	8.00E+02	1.20E+02	6.667	1	99.091	1.897

Pu*/Ru106

Sample ID	Waste Component	Waste Group	Pu* (Bq/total)	Ru106 (Bq/total)	Pu*/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-1	bottle	Poly	2.90E+02	6.20E+05	0.000	1	0.909	-7.668
LN-11	bottle	Glass	5.10E+02	5.60E+04	0.009	1	2.727	-4.699
LN-13	bottle	Glass	1.20E+02	4.70E+03	0.026	1	4.545	-3.668
LN-15	tool	Glass	3.20E+05	5.20E+06	0.062	1	6.364	-2.788
LN-19	bottle	Glass	2.00E+03	2.20E+04	0.091	1	8.182	-2.398
LN-25	bottle	Poly	3.60E+03	2.70E+04	0.133	1	10.000	-2.015
LN-26	bottle	Metal	4.80E+02	2.60E+03	0.185	1	11.818	-1.689
LN-28	bottle	Metal	6.80E+02	3.30E+03	0.206	1	13.636	-1.580
LN-3	bottle	Wipes	1.20E+02	5.10E+02	0.235	1	15.455	-1.447
LN-33	valve	Poly	4.85E+02	1.80E+03	0.269	1	17.273	-1.311
LN-35	bottle	Poly	5.20E+02	1.90E+03	0.274	1	19.091	-1.296
LN-36	cell	Metal	2.10E+03	7.30E+03	0.288	1	20.909	-1.246
LN-38	tool	Metal	9.30E+02	3.00E+03	0.310	1	22.727	-1.171
LN-39	cell	Poly	5.80E+01	1.80E+02	0.322	1	24.545	-1.133
LN-4	bottle	Glass	6.90E+03	2.10E+04	0.329	1	26.364	-1.113
LN-40	hose	Glass	4.60E+02	1.30E+03	0.354	1	28.182	-1.039
LN-41	column	Metal	4.00E+02	1.10E+03	0.364	1	30.000	-1.012
LN-44	cap	Metal	1.10E+03	2.60E+03	0.423	1	31.818	-0.860
LN-46	can	Wipes	1.50E+02	3.10E+02	0.484	1	33.636	-0.726
LN-48	tool	Poly	2.50E+02	4.90E+02	0.510	1	35.455	-0.673
LN-49	socket	Glass	4.00E+02	7.60E+02	0.526	1	37.273	-0.642
LN-54	case	Poly	6.20E+02	1.10E+03	0.564	1	39.091	-0.573
LN-6	bottle	Metal	5.70E+02	9.80E+02	0.582	1	40.909	-0.542
LN-7	tool	Glass	4.00E+03	6.60E+03	0.606	1	42.727	-0.501
LN-8	bottle	Wipes	3.50E+02	5.70E+02	0.614	1	44.545	-0.488
LN-9	bulb	Poly	1.10E+02	1.50E+02	0.733	1	46.364	-0.310
LN-GL	bottles	Metal	2.90E+05	3.70E+05	0.784	1	48.182	-0.244
LN-ML	tool	Wipes	1.55E+02	1.90E+02	0.816	1	50.000	-0.204
RH9A	Melt	Poly	9.10E+01	1.10E+02	0.827	1	51.818	-0.190
RH9AA	Melt	Glass	1.10E+03	1.20E+03	0.917	1	53.636	-0.087
RH9C	Melt	Glass	3.00E+02	3.20E+02	0.938	1	55.455	-0.065
RH9D	bckt	Poly	4.40E+02	4.20E+02	1.048	1	57.273	0.047
RH9E	Valve	Metal	9.50E+02	8.80E+02	1.080	1	59.091	0.077
RH9EE	Valve	Metal	4.00E+02	3.70E+02	1.081	1	60.909	0.078
RH9F	Valve	Poly	5.00E+02	4.60E+02	1.087	1	62.727	0.083
RH9G	Valve	Poly	3.50E+02	3.10E+02	1.129	1	64.545	0.121
RH9H	Light Cord	Poly	2.60E+02	2.30E+02	1.130	1	66.364	0.123
RH9I	MSM Boot	Poly	5.15E+02	4.50E+02	1.144	1	68.182	0.135
RH9J	Lid	Glass	1.10E+03	9.10E+02	1.209	1	70.000	0.190
RH9K	Lid	Poly	5.50E+03	4.10E+03	1.341	1	71.818	0.294
RH9KK	Lid	Metal	2.15E+02	1.60E+02	1.344	1	73.636	0.295
RH9L	bottle	Metal	1.40E+03	7.80E+02	1.795	1	75.455	0.585
RH9LL	bottle	Metal	1.80E+03	1.00E+03	1.800	1	77.273	0.588
RH9M	bottle	Glass	4.90E+03	2.30E+03	2.130	1	79.091	0.756
RH9N	glassware	Poly	2.60E+02	1.20E+02	2.167	1	80.909	0.773
RH9O	housing	Glass	4.00E+03	1.70E+03	2.353	1	82.727	0.856
RH9P	Tool	Glass	4.70E+03	1.80E+03	2.611	1	84.545	0.960
RH9Q	Wire	Metal	6.20E+03	2.20E+03	2.818	1	86.364	1.036
RH9QQ	Wire	Glass	6.30E+03	2.20E+03	2.864	1	88.182	1.052
RH9R	Lid	Glass	6.60E+03	2.30E+03	2.870	1	90.000	1.054
RH9S	Wipes	Wipes	2.90E+02	1.00E+02	2.900	1	91.818	1.065
RH9SS	Wipes	Metal	3.80E+03	1.30E+03	2.923	1	93.636	1.073
RH9T	Wipes	Glass	6.30E+03	1.90E+03	3.316	1	95.455	1.199
RH9U	Wipes	Metal	8.75E+02	1.50E+02	5.833	1	97.273	1.764
RH9V	Wipes	Glass	8.90E+03	1.00E+03	8.900	1	99.091	2.186

Pu242/Ru106

Sample ID	Waste Component	Waste Group	Pu242 (Bq/total)	Ru106 (Bq/total)	Pu242/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	8.70E+00	6.20E+05	0.000	2	2.727	-11.174
LN-1	bottle	Glass	2.00E+01	5.60E+04	0.000	0	2.727	-7.937
LN-GL	bottles	Glass	4.20E+03	5.20E+06	0.001	2	6.364	-7.121
LN-11	bottle	Glass	2.00E+01	2.20E+04	0.001	0	6.364	-7.003
LN-33	valve	Poly	5.00E+01	2.70E+04	0.002	1	8.182	-6.292
LN-4	bottle	Glass	2.00E+01	6.60E+03	0.003	2	11.818	-5.799
LN-26	bottle	Glass	6.50E+01	2.10E+04	0.003	0	11.818	-5.778
LN-39	cell	Metal	9.30E+00	2.20E+03	0.004	2	15.455	-5.466
LN-48	tool	Metal	1.30E+01	3.00E+03	0.004	0	15.455	-5.441
LN-41	column	Metal	3.30E+01	7.30E+03	0.005	2	19.091	-5.399
LN-46	can	Metal	1.70E+01	3.30E+03	0.005	0	19.091	-5.268
LN-25	bottle	Glass	8.00E+00	1.20E+03	0.007	2	22.727	-5.011
LN-3	bottle	Glass	1.50E+01	2.20E+03	0.007	0	22.727	-4.988
LN-6	bottle	Glass	1.60E+01	1.90E+03	0.008	1	24.545	-4.777
LN-38	tool	Metal	2.80E+01	2.60E+03	0.011	1	26.364	-4.531
LN-54	case	Metal	3.40E+01	2.60E+03	0.013	1	28.182	-4.337
LN-9	bulb	Glass	3.90E+01	2.30E+03	0.017	1	30.000	-4.077
LN-36	cell	Metal	2.40E+01	1.30E+03	0.018	1	31.818	-3.992
LN-19	bottle	Glass	3.20E+01	1.70E+03	0.019	1	33.636	-3.973
LN-13	bottle	Glass	2.00E+01	1.00E+03	0.020	1	35.455	-3.912
LN-28	bottle	Glass	4.90E+01	2.30E+03	0.021	1	37.273	-3.849
LN-8	bottle	Glass	4.40E+01	1.80E+03	0.024	1	39.091	-3.711
RH9LL	bottle	Glass	1.20E+02	4.70E+03	0.026	1	40.909	-3.668
LN-ML	tool	Metal	1.30E+04	3.70E+05	0.035	1	42.727	-3.349
RH9O	housing	Glass	5.25E+01	1.30E+03	0.040	1	44.545	-3.209
LN-35	bottle	Poly	2.00E+02	4.10E+03	0.049	1	46.364	-3.020
LN-7	tool	Metal	4.80E+01	8.80E+02	0.055	1	48.182	-2.909
LN-44	cap	Metal	4.60E+01	7.80E+02	0.059	1	50.000	-2.831
LN-15	tool	Metal	6.60E+01	1.00E+03	0.066	1	51.818	-2.718
LN-49	socket	Metal	8.20E+01	1.10E+03	0.075	1	53.636	-2.596
RH9D	bckt	Poly	4.85E+02	1.80E+03	0.269	1	55.455	-1.311
RH9J	Lid	Poly	5.20E+02	1.90E+03	0.274	1	57.273	-1.296
RH9A	Melt	Poly	1.10E+02	1.50E+02	0.733	1	59.091	-0.310
RH9U	Wipes	Wipes	1.55E+02	1.90E+02	0.816	1	60.909	-0.204
RH9AA	Melt	Poly	9.10E+01	1.10E+02	0.827	1	62.727	-0.190
RH9V	Wipes	Wipes	5.85E+02	5.70E+02	1.026	1	64.545	0.026
RH9C	Melt	Poly	3.50E+02	3.10E+02	1.129	1	66.364	0.121
RH9E	Valve	Poly	2.60E+02	2.30E+02	1.130	1	68.182	0.123
RH9H	Light Cord	Poly	5.15E+02	4.50E+02	1.144	1	70.000	0.135
RH9SS	Wipes	Wipes	6.10E+02	5.10E+02	1.196	1	71.818	0.179
RH9I	MSM Boot	Poly	6.35E+02	4.90E+02	1.296	1	73.636	0.259
RH9M	bottle	Glass	1.00E+03	7.60E+02	1.316	1	75.455	0.274
RH9R	Lid	Metal	2.15E+02	1.60E+02	1.344	1	77.273	0.295
RH9T	Wipes	Wipes	1.65E+02	1.00E+02	1.650	1	79.091	0.501
RH9L	bottle	Glass	6.00E+02	3.20E+02	1.875	1	80.909	0.629
RH9QQ	Wire	Metal	1.95E+03	9.80E+02	1.990	1	82.727	0.688
RH9N	glassware	Glass	1.95E+03	9.10E+02	2.143	1	84.545	0.762
RH9F	Valve	Poly	1.00E+03	4.60E+02	2.174	1	86.364	0.777
RH9G	Valve	Poly	2.90E+02	1.20E+02	2.417	1	88.182	0.882
RH9K	Lid	Poly	1.10E+03	4.20E+02	2.619	1	90.000	0.963
RH9P	Tool	Metal	9.90E+02	3.70E+02	2.676	1	91.818	0.984
RH9KK	Lid	Poly	5.75E+02	1.80E+02	3.194	1	93.636	1.161
RH9S	Wipes	Wipes	1.50E+03	3.10E+02	4.839	1	95.455	1.577
RH9EE	Valve	Poly	6.20E+03	1.10E+03	5.636	1	97.273	1.729
RH9Q	Wire	Metal	8.75E+02	1.50E+02	5.833	1	99.091	1.764

Am241/Ru106

Sample ID	Waste Component	Waste Group	Am241 (Bq/total)	Ru106 (Bq/total)	Am241/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	1.10E+04	6.20E+05	0.018	1	0.909	-4.032
RH9O	housing	Glass	5.40E+01	1.30E+03	0.042	1	2.727	-3.181
LN-26	bottle	Glass	1.70E+03	2.10E+04	0.081	1	4.545	-2.514
LN-GL	bottles	Glass	6.20E+05	5.20E+06	0.119	1	6.364	-2.127
LN-1	bottle	Glass	7.30E+03	5.60E+04	0.130	1	8.182	-2.037
RH9LL	bottle	Glass	8.50E+02	4.70E+03	0.181	1	10.000	-1.710
LN-11	bottle	Glass	6.20E+03	2.20E+04	0.282	1	11.818	-1.266
LN-4	bottle	Glass	2.20E+03	6.60E+03	0.333	1	13.636	-1.099
RH9J	Lid	Poly	7.20E+02	1.90E+03	0.379	1	15.455	-0.970
LN-33	valve	Poly	1.50E+04	2.70E+04	0.556	1	17.273	-0.588
RH9D	bckt	Poly	1.00E+03	1.80E+03	0.556	1	19.091	-0.588
LN-46	can	Metal	2.00E+03	3.30E+03	0.606	1	20.909	-0.501
LN-9	bulb	Glass	1.50E+03	2.30E+03	0.652	1	22.727	-0.427
LN-38	tool	Metal	1.70E+03	2.60E+03	0.654	1	24.545	-0.425
LN-49	socket	Metal	8.90E+02	1.10E+03	0.809	1	26.364	-0.212
RH9T	Wipes	Wipes	8.70E+01	1.00E+02	0.870	1	28.182	-0.139
LN-28	bottle	Glass	2.20E+03	2.30E+03	0.957	1	30.000	-0.044
LN-41	column	Metal	7.20E+03	7.30E+03	0.986	1	31.818	-0.014
RH9F	Valve	Poly	4.60E+02	4.60E+02	1.000	1	33.636	0.000
LN-19	bottle	Glass	1.90E+03	1.70E+03	1.118	1	35.455	0.111
LN-3	bottle	Glass	2.50E+03	2.20E+03	1.136	1	37.273	0.128
RH9SS	Wipes	Wipes	6.20E+02	5.10E+02	1.216	1	39.091	0.195
LN-48	tool	Metal	3.70E+03	3.00E+03	1.233	1	40.909	0.210
RH9G	Valve	Poly	1.60E+02	1.20E+02	1.333	1	42.727	0.288
RH9V	Wipes	Wipes	7.60E+02	5.70E+02	1.333	1	44.545	0.288
RH9R	Lid	Metal	2.20E+02	1.60E+02	1.375	1	46.364	0.318
RH9KK	Lid	Poly	2.50E+02	1.80E+02	1.389	1	48.182	0.329
RH9A	Melt	Poly	2.20E+02	1.50E+02	1.467	1	50.000	0.383
RH9E	Valve	Poly	3.50E+02	2.30E+02	1.522	1	51.818	0.420
RH9AA	Melt	Poly	1.70E+02	1.10E+02	1.545	1	53.636	0.435
RH9U	Wipes	Wipes	3.20E+02	1.90E+02	1.684	1	55.455	0.521
LN-8	bottle	Glass	3.20E+03	1.80E+03	1.778	1	57.273	0.575
RH9M	bottle	Glass	1.40E+03	7.60E+02	1.842	1	59.091	0.611
RH9I	MSM Boot	Poly	9.10E+02	4.90E+02	1.857	1	60.909	0.619
LN-54	case	Metal	5.20E+03	2.60E+03	2.000	1	62.727	0.693
RH9H	Light Cord	Poly	9.40E+02	4.50E+02	2.089	1	64.545	0.737
RH9C	Melt	Poly	7.40E+02	3.10E+02	2.387	1	66.364	0.870
LN-ML	tool	Metal	9.30E+05	3.70E+05	2.514	1	68.182	0.922
RH9EE	Valve	Poly	2.80E+03	1.10E+03	2.545	1	70.000	0.934
RH9L	bottle	Glass	8.20E+02	3.20E+02	2.563	1	71.818	0.941
LN-13	bottle	Glass	2.80E+03	1.00E+03	2.800	1	73.636	1.030
LN-44	cap	Metal	2.20E+03	7.80E+02	2.821	1	75.455	1.037
LN-7	tool	Metal	2.50E+03	8.80E+02	2.841	1	77.273	1.044
RH9K	Lid	Poly	1.30E+03	4.20E+02	3.095	1	79.091	1.130
LN-6	bottle	Glass	7.10E+03	1.90E+03	3.737	1	80.909	1.318
LN-25	bottle	Glass	4.90E+03	1.20E+03	4.083	1	82.727	1.407
RH9QQ	Wire	Metal	5.60E+03	9.80E+02	5.714	1	84.545	1.743
LN-15	tool	Metal	5.90E+03	1.00E+03	5.900	1	86.364	1.775
RH9P	Tool	Metal	2.20E+03	3.70E+02	5.946	1	88.182	1.783
RH9S	Wipes	Wipes	2.10E+03	3.10E+02	6.774	1	90.000	1.913
RH9N	glassware	Glass	1.10E+04	9.10E+02	12.088	1	91.818	2.492
LN-35	bottle	Poly	5.80E+04	4.10E+03	14.146	1	93.636	2.649
RH9Q	Wire	Metal	3.00E+03	1.50E+02	20.000	1	95.455	2.996
LN-39	cell	Metal	1.10E+05	2.20E+03	50.000	1	97.273	3.912
LN-36	cell	Metal	8.30E+04	1.30E+03	63.846	1	99.091	4.156

Am243/Ru106

Sample ID	Waste Component	Waste Group	Am243 (Bq/total)	Ru106 (Bq/total)	Am243/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9O	housing	Glass	4.00E+00	1.30E+03	0.003	1	0.909	-5.784
LN-1	bottle	Glass	4.50E+02	5.60E+04	0.008	1	2.727	-4.824
RH9LL	bottle	Glass	4.20E+01	4.70E+03	0.009	2	6.364	-4.718
LN-40	hose	Poly	5.80E+03	6.20E+05	0.009	0	6.364	-4.672
LN-26	bottle	Glass	2.40E+02	2.10E+04	0.011	1	8.182	-4.472
LN-GL	bottles	Glass	7.10E+04	5.20E+06	0.014	1	10.000	-4.294
RH9J	Lid	Poly	2.90E+01	1.90E+03	0.015	1	11.818	-4.182
RH9D	bckt	Poly	2.80E+01	1.80E+03	0.016	1	13.636	-4.163
LN-11	bottle	Glass	4.10E+02	2.20E+04	0.019	1	15.455	-3.983
LN-41	column	Metal	2.10E+02	7.30E+03	0.029	1	17.273	-3.549
LN-46	can	Metal	1.10E+02	3.30E+03	0.033	1	19.091	-3.401
RH9A	Melt	Poly	5.10E+00	1.50E+02	0.034	1	20.909	-3.381
RH9U	Wipes	Wipes	8.00E+00	1.90E+02	0.042	1	22.727	-3.168
LN-33	valve	Poly	1.30E+03	2.70E+04	0.048	1	24.545	-3.033
LN-48	tool	Metal	1.50E+02	3.00E+03	0.050	1	26.364	-2.996
RH9F	Valve	Poly	2.40E+01	4.60E+02	0.052	1	28.182	-2.953
RH9KK	Lid	Poly	1.10E+01	1.80E+02	0.061	1	30.000	-2.795
LN-4	bottle	Glass	4.10E+02	6.60E+03	0.062	1	31.818	-2.779
RH9R	Lid	Metal	1.00E+01	1.60E+02	0.063	1	33.636	-2.773
LN-38	tool	Metal	1.70E+02	2.60E+03	0.065	1	35.455	-2.727
RH9C	Melt	Poly	2.10E+01	3.10E+02	0.068	1	37.273	-2.692
RH9SS	Wipes	Wipes	3.60E+01	5.10E+02	0.071	1	39.091	-2.651
RH9G	Valve	Poly	8.90E+00	1.20E+02	0.074	1	40.909	-2.601
RH9T	Wipes	Wipes	7.50E+00	1.00E+02	0.075	1	42.727	-2.590
LN-49	socket	Metal	8.80E+01	1.10E+03	0.080	1	44.545	-2.526
LN-19	bottle	Glass	1.40E+02	1.70E+03	0.082	1	46.364	-2.497
RH9I	MSM Boot	Poly	4.20E+01	4.90E+02	0.086	1	48.182	-2.457
LN-35	bottle	Poly	3.70E+02	4.10E+03	0.090	1	50.000	-2.405
LN-7	tool	Metal	8.00E+01	8.80E+02	0.091	1	51.818	-2.398
RH9AA	Melt	Poly	1.10E+01	1.10E+02	0.100	1	53.636	-2.303
RH9H	Light Cord	Poly	4.60E+01	4.50E+02	0.102	1	55.455	-2.281
RH9L	bottle	Glass	3.40E+01	3.20E+02	0.106	1	57.273	-2.242
RH9N	glassware	Glass	1.00E+02	9.10E+02	0.110	1	59.091	-2.208
RH9M	bottle	Glass	8.90E+01	7.60E+02	0.117	1	60.909	-2.145
RH9V	Wipes	Wipes	6.90E+01	5.70E+02	0.121	1	62.727	-2.112
RH9QQ	Wire	Metal	1.20E+02	9.80E+02	0.122	1	64.545	-2.100
LN-54	case	Metal	3.20E+02	2.60E+03	0.123	1	66.364	-2.095
LN-28	bottle	Glass	2.90E+02	2.30E+03	0.126	1	68.182	-2.071
LN-ML	tool	Metal	4.90E+04	3.70E+05	0.132	1	70.000	-2.022
LN-9	bulb	Glass	3.10E+02	2.30E+03	0.135	1	71.818	-2.004
RH9E	Valve	Poly	3.20E+01	2.30E+02	0.139	1	73.636	-1.972
LN-25	bottle	Glass	2.20E+02	1.20E+03	0.183	1	75.455	-1.696
RH9EE	Valve	Poly	2.10E+02	1.10E+03	0.191	1	77.273	-1.656
RH9K	Lid	Poly	8.10E+01	4.20E+02	0.193	1	79.091	-1.646
LN-8	bottle	Glass	3.70E+02	1.80E+03	0.206	1	80.909	-1.582
LN-44	cap	Metal	1.90E+02	7.80E+02	0.244	1	82.727	-1.412
LN-3	bottle	Glass	5.70E+02	2.20E+03	0.259	1	84.545	-1.351
RH9P	Tool	Metal	9.60E+01	3.70E+02	0.259	1	86.364	-1.349
RH9Q	Wire	Metal	4.30E+01	1.50E+02	0.287	1	88.182	-1.249
LN-15	tool	Metal	2.90E+02	1.00E+03	0.290	1	90.000	-1.238
LN-13	bottle	Glass	3.00E+02	1.00E+03	0.300	1	91.818	-1.204
LN-6	bottle	Glass	6.80E+02	1.90E+03	0.358	1	93.636	-1.028
LN-39	cell	Metal	1.20E+03	2.20E+03	0.545	1	95.455	-0.606
LN-36	cell	Metal	1.00E+03	1.30E+03	0.769	1	97.273	-0.262
RH9S	Wipes	Wipes	3.20E+02	3.10E+02	1.032	1	99.091	0.032

Cf252/Ru106

Sample ID	Waste Component	Waste Group	Cf252 (Bq/total)	Ru106 (Bq/total)	Cf252/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	1.80E+04	6.20E+05	0.029	1	0.909	-3.539
RH9LL	bottle	Glass	1.80E+02	4.70E+03	0.038	1	2.727	-3.262
LN-11	bottle	Glass	5.50E+03	2.20E+04	0.250	2	6.364	-1.386
LN-GL	bottles	Glass	1.30E+06	5.20E+06	0.250	0	6.364	-1.386
LN-26	bottle	Glass	5.80E+03	2.10E+04	0.276	1	8.182	-1.287
LN-1	bottle	Glass	1.60E+04	5.60E+04	0.286	1	10.000	-1.253
LN-4	bottle	Glass	2.50E+03	6.60E+03	0.379	1	11.818	-0.971
LN-33	valve	Poly	1.30E+04	2.70E+04	0.481	1	13.636	-0.731
RH9D	bckt	Poly	8.80E+02	1.80E+03	0.489	1	15.455	-0.716
LN-46	can	Metal	1.80E+03	3.30E+03	0.545	1	17.273	-0.606
LN-9	bulb	Glass	1.60E+03	2.30E+03	0.696	1	19.091	-0.363
LN-49	socket	Metal	7.80E+02	1.10E+03	0.709	1	20.909	-0.344
LN-38	tool	Metal	1.90E+03	2.60E+03	0.731	1	22.727	-0.314
LN-41	column	Metal	6.00E+03	7.30E+03	0.822	1	24.545	-0.196
LN-48	tool	Metal	2.50E+03	3.00E+03	0.833	1	26.364	-0.182
LN-28	bottle	Glass	2.10E+03	2.30E+03	0.913	1	28.182	-0.091
LN-25	bottle	Glass	1.10E+03	1.20E+03	0.917	1	30.000	-0.087
LN-54	case	Metal	2.50E+03	2.60E+03	0.962	1	31.818	-0.039
RH9O	housing	Glass	1.40E+03	1.30E+03	1.077	1	33.636	0.074
LN-3	bottle	Glass	2.60E+03	2.20E+03	1.182	1	35.455	0.167
LN-19	bottle	Glass	2.10E+03	1.70E+03	1.235	1	37.273	0.211
RH9G	Valve	Poly	1.50E+02	1.20E+02	1.250	1	39.091	0.223
RH9S	Wipes	Wipes	3.90E+02	3.10E+02	1.258	1	40.909	0.230
LN-44	cap	Metal	1.20E+03	7.80E+02	1.538	1	42.727	0.431
LN-8	bottle	Glass	2.80E+03	1.80E+03	1.556	2	46.364	0.442
RH9H	Light Cord	Poly	7.00E+02	4.50E+02	1.556	0	46.364	0.442
LN-6	bottle	Glass	3.20E+03	1.90E+03	1.684	2	50.000	0.521
RH9U	Wipes	Wipes	3.20E+02	1.90E+02	1.684	0	50.000	0.521
RH9F	Valve	Poly	8.10E+02	4.60E+02	1.761	1	51.818	0.566
RH9A	Melt	Poly	2.80E+02	1.50E+02	1.867	1	53.636	0.624
RH9I	MSM Boot	Poly	9.40E+02	4.90E+02	1.918	1	55.455	0.651
RH9T	Wipes	Wipes	2.00E+02	1.00E+02	2.000	1	57.273	0.693
RH9AA	Melt	Poly	2.30E+02	1.10E+02	2.091	1	59.091	0.738
RH9C	Melt	Poly	6.60E+02	3.10E+02	2.129	1	60.909	0.756
RH9SS	Wipes	Wipes	1.20E+03	5.10E+02	2.353	1	62.727	0.856
LN-39	cell	Metal	5.20E+03	2.20E+03	2.364	1	64.545	0.860
RH9R	Lid	Metal	3.90E+02	1.60E+02	2.438	1	66.364	0.891
LN-13	bottle	Glass	2.50E+03	1.00E+03	2.500	1	68.182	0.916
RH9EE	Valve	Poly	3.10E+03	1.10E+03	2.818	1	70.000	1.036
RH9E	Valve	Poly	7.20E+02	2.30E+02	3.130	1	71.818	1.141
RH9N	glassware	Glass	2.90E+03	9.10E+02	3.187	1	73.636	1.159
RH9P	Tool	Metal	1.20E+03	3.70E+02	3.243	1	75.455	1.177
LN-36	cell	Metal	4.50E+03	1.30E+03	3.462	1	77.273	1.242
RH9QQ	Wire	Metal	3.40E+03	9.80E+02	3.469	1	79.091	1.244
RH9V	Wipes	Wipes	2.10E+03	5.70E+02	3.684	1	80.909	1.304
RH9J	Lid	Poly	7.10E+03	1.90E+03	3.737	1	82.727	1.318
RH9M	bottle	Glass	3.20E+03	7.60E+02	4.211	1	84.545	1.438
LN-35	bottle	Poly	2.10E+04	4.10E+03	5.122	1	86.364	1.634
LN-ML	tool	Metal	2.00E+06	3.70E+05	5.405	1	88.182	1.687
LN-7	tool	Metal	4.80E+03	8.80E+02	5.455	1	90.000	1.696
RH9Q	Wire	Metal	8.40E+02	1.50E+02	5.600	1	91.818	1.723
RH9L	bottle	Glass	1.90E+03	3.20E+02	5.938	1	93.636	1.781
RH9K	Lid	Poly	3.10E+03	4.20E+02	7.381	1	95.455	1.999
LN-15	tool	Metal	1.00E+04	1.00E+03	10.000	1	97.273	2.303
RH9KK	Lid	Poly	2.70E+03	1.80E+02	15.000	1	99.091	2.708

Cm242/Ru106

Sample ID	Waste Component	Waste Group	Cm242 (Bq/total)	Ru106 (Bq/total)	Cm242/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-1	hose	Poly	1.30E+04	6.20E+05	0.021	1	0.909	-3.865
LN-11	bottle	Glass	1.20E+02	4.70E+03	0.026	1	2.727	-3.668
LN-13	housing	Glass	5.30E+01	1.30E+03	0.041	1	4.545	-3.200
LN-15	bottles	Glass	5.00E+05	5.20E+06	0.096	1	6.364	-2.342
LN-19	can	Metal	3.20E+02	3.30E+03	0.097	1	8.182	-2.333
LN-25	bottle	Glass	8.80E+03	5.60E+04	0.157	1	10.000	-1.851
LN-26	column	Metal	1.70E+03	7.30E+03	0.233	1	11.818	-1.457
LN-28	socket	Metal	3.00E+02	1.10E+03	0.273	1	13.636	-1.299
LN-3	bottle	Glass	5.80E+03	2.10E+04	0.276	1	15.455	-1.287
LN-33	valve	Poly	9.40E+03	2.70E+04	0.348	1	17.273	-1.055
LN-35	bottle	Glass	6.10E+02	1.70E+03	0.359	1	19.091	-1.025
LN-36	bottle	Glass	2.70E+03	6.60E+03	0.409	1	20.909	-0.894
LN-38	bckt	Poly	8.00E+02	1.80E+03	0.444	1	22.727	-0.811
LN-39	tool	Metal	1.40E+03	3.00E+03	0.467	1	24.545	-0.762
LN-4	bottle	Glass	1.20E+03	2.30E+03	0.522	1	26.364	-0.651
LN-40	tool	Metal	1.50E+03	2.60E+03	0.577	1	28.182	-0.550
LN-41	Wipes	Wipes	2.10E+02	3.10E+02	0.677	1	30.000	-0.389
LN-44	bottle	Glass	1.60E+04	2.20E+04	0.727	1	31.818	-0.318
LN-46	Valve	Poly	1.70E+02	2.30E+02	0.739	1	33.636	-0.302
LN-48	case	Metal	2.30E+03	2.60E+03	0.885	1	35.455	-0.123
LN-49	Valve	Poly	1.10E+02	1.20E+02	0.917	1	37.273	-0.087
LN-54	Light Cord	Poly	4.30E+02	4.50E+02	0.956	1	39.091	-0.045
LN-6	tool	Metal	4.10E+05	3.70E+05	1.108	1	40.909	0.103
LN-7	Melt	Poly	1.70E+02	1.50E+02	1.133	1	42.727	0.125
LN-8	Lid	Poly	2.20E+03	1.90E+03	1.158	1	44.545	0.147
LN-9	Valve	Poly	5.90E+02	4.60E+02	1.283	1	46.364	0.249
LN-GL	bottle	Glass	3.10E+03	2.20E+03	1.409	1	48.182	0.343
LN-ML	Wipes	Wipes	7.30E+02	5.10E+02	1.431	1	50.000	0.359
RH9A	Wipes	Wipes	1.50E+02	1.00E+02	1.500	1	51.818	0.405
RH9AA	Wipes	Wipes	2.90E+02	1.90E+02	1.526	1	53.636	0.423
RH9C	MSM Boot	Poly	7.60E+02	4.90E+02	1.551	1	55.455	0.439
RH9D	Wipes	Wipes	9.50E+02	5.70E+02	1.667	1	57.273	0.511
RH9E	Melt	Poly	5.30E+02	3.10E+02	1.710	1	59.091	0.536
RH9EE	Melt	Poly	1.90E+02	1.10E+02	1.727	1	60.909	0.547
RH9F	bottle	Glass	2.30E+03	1.20E+03	1.917	1	62.727	0.651
RH9G	bottle	Glass	3.70E+03	1.90E+03	1.947	1	64.545	0.666
RH9H	bottle	Glass	3.60E+03	1.80E+03	2.000	1	66.364	0.693
RH9I	bottle	Glass	2.10E+03	1.00E+03	2.100	1	68.182	0.742
RH9J	Lid	Metal	3.40E+02	1.60E+02	2.125	1	70.000	0.754
RH9K	Tool	Metal	8.00E+02	3.70E+02	2.162	1	71.818	0.771
RH9KK	bottle	Glass	2.00E+03	7.60E+02	2.632	1	73.636	0.968
RH9L	glassware	Glass	2.40E+03	9.10E+02	2.637	1	75.455	0.970
RH9LL	bulb	Glass	6.40E+03	2.30E+03	2.783	1	77.273	1.023
RH9M	cell	Metal	7.80E+03	2.20E+03	3.545	1	79.091	1.266
RH9N	cell	Metal	5.00E+03	1.30E+03	3.846	1	80.909	1.347
RH9O	bottle	Glass	1.30E+03	3.20E+02	4.063	1	82.727	1.402
RH9P	Wire	Metal	4.00E+03	9.80E+02	4.082	1	84.545	1.406
RH9Q	tool	Metal	3.80E+03	8.80E+02	4.318	1	86.364	1.463
RH9QQ	bottle	Poly	1.90E+04	4.10E+03	4.634	1	88.182	1.533
RH9R	cap	Metal	4.10E+03	7.80E+02	5.256	1	90.000	1.659
RH9S	tool	Metal	5.70E+03	1.00E+03	5.700	1	91.818	1.740
RH9SS	Lid	Poly	2.40E+03	4.20E+02	5.714	1	93.636	1.743
RH9T	Wire	Metal	1.60E+03	1.50E+02	10.667	1	95.455	2.367
RH9U	Lid	Poly	2.20E+03	1.80E+02	12.222	1	97.273	2.503
RH9V	Valve	Poly	1.60E+04	1.10E+03	14.545	1	99.091	2.677

Cm246/Ru106

Sample ID	Waste Component	Waste Group	Cm246 (Bq/total)	Ru106 (Bq/total)	Cm246/Ru106 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	1.45E+04	6.20E+05	0.023	1	0.909	-3.756
RH9LL	bottle	Glass	1.20E+02	4.70E+03	0.026	1	2.727	-3.668
RH9O	housing	Glass	5.25E+01	1.30E+03	0.040	1	4.545	-3.209
LN-46	can	Metal	3.80E+02	3.30E+03	0.115	1	6.364	-2.162
LN-1	bottle	Glass	1.10E+04	5.60E+04	0.196	1	8.182	-1.627
LN-GL	bottles	Glass	1.20E+06	5.20E+06	0.231	1	10.000	-1.466
RH9D	bckt	Poly	4.85E+02	1.80E+03	0.269	1	11.818	-1.311
RH9J	Lid	Poly	5.20E+02	1.90E+03	0.274	1	13.636	-1.296
RH9V	Wipes	Wipes	1.80E+02	5.70E+02	0.316	1	15.455	-1.153
LN-38	tool	Metal	8.40E+02	2.60E+03	0.323	1	17.273	-1.130
LN-11	bottle	Glass	1.10E+04	2.20E+04	0.500	1	19.091	-0.693
LN-33	valve	Poly	1.40E+04	2.70E+04	0.519	1	20.909	-0.657
RH9EE	Valve	Poly	6.20E+02	1.10E+03	0.564	1	22.727	-0.573
LN-41	column	Metal	4.80E+03	7.30E+03	0.658	1	24.545	-0.419
LN-26	bottle	Glass	1.45E+04	2.10E+04	0.690	1	26.364	-0.370
LN-54	case	Metal	1.80E+03	2.60E+03	0.692	1	28.182	-0.368
RH9A	Melt	Poly	1.10E+02	1.50E+02	0.733	1	30.000	-0.310
RH9K	Lid	Poly	3.30E+02	4.20E+02	0.786	1	31.818	-0.241
RH9U	Wipes	Wipes	1.55E+02	1.90E+02	0.816	1	33.636	-0.204
RH9AA	Melt	Poly	9.10E+01	1.10E+02	0.827	1	35.455	-0.190
RH9F	Valve	Poly	4.00E+02	4.60E+02	0.870	1	37.273	-0.140
LN-49	socket	Metal	1.20E+03	1.10E+03	1.091	1	39.091	0.087
RH9C	Melt	Poly	3.50E+02	3.10E+02	1.129	1	40.909	0.121
RH9E	Valve	Poly	2.60E+02	2.30E+02	1.130	1	42.727	0.123
RH9H	Light Cord	Poly	5.15E+02	4.50E+02	1.144	1	44.545	0.135
RH9SS	Wipes	Wipes	6.10E+02	5.10E+02	1.196	1	46.364	0.179
RH9I	MSM Boot	Poly	6.30E+02	4.90E+02	1.286	1	48.182	0.251
LN-48	tool	Metal	3.90E+03	3.00E+03	1.300	1	50.000	0.262
RH9M	bottle	Glass	1.00E+03	7.60E+02	1.316	1	51.818	0.274
RH9R	Lid	Metal	2.15E+02	1.60E+02	1.344	1	53.636	0.295
RH9T	Wipes	Wipes	1.60E+02	1.00E+02	1.600	1	55.455	0.470
RH9L	bottle	Glass	6.00E+02	3.20E+02	1.875	1	57.273	0.629
LN-4	bottle	Glass	1.30E+04	6.60E+03	1.970	1	59.091	0.678
LN-ML	tool	Metal	7.30E+05	3.70E+05	1.973	1	60.909	0.680
RH9QQ	Wire	Metal	1.95E+03	9.80E+02	1.990	1	62.727	0.688
RH9N	glassware	Glass	1.95E+03	9.10E+02	2.143	1	64.545	0.762
LN-25	bottle	Glass	2.70E+03	1.20E+03	2.250	1	66.364	0.811
LN-7	tool	Metal	2.10E+03	8.80E+02	2.386	1	68.182	0.870
RH9G	Valve	Poly	2.90E+02	1.20E+02	2.417	1	70.000	0.882
RH9P	Tool	Metal	9.90E+02	3.70E+02	2.676	1	71.818	0.984
RH9KK	Lid	Poly	5.75E+02	1.80E+02	3.194	1	73.636	1.161
LN-15	tool	Metal	3.30E+03	1.00E+03	3.300	1	75.455	1.194
LN-35	bottle	Poly	1.50E+04	4.10E+03	3.659	1	77.273	1.297
LN-44	cap	Metal	3.50E+03	7.80E+02	4.487	1	79.091	1.501
LN-28	bottle	Glass	1.10E+04	2.30E+03	4.783	1	80.909	1.565
RH9S	Wipes	Wipes	1.50E+03	3.10E+02	4.839	1	82.727	1.577
LN-19	bottle	Glass	9.05E+03	1.70E+03	5.324	1	84.545	1.672
RH9Q	Wire	Metal	8.75E+02	1.50E+02	5.833	1	86.364	1.764
LN-8	bottle	Glass	1.60E+04	1.80E+03	8.889	1	88.182	2.185
LN-9	bulb	Glass	2.05E+04	2.30E+03	8.913	1	90.000	2.188
LN-6	bottle	Glass	2.30E+04	1.90E+03	12.105	1	91.818	2.494
LN-3	bottle	Glass	2.85E+04	2.20E+03	12.955	1	93.636	2.561
LN-39	cell	Metal	3.90E+04	2.20E+03	17.727	1	95.455	2.875
LN-36	cell	Metal	2.90E+04	1.30E+03	22.308	1	97.273	3.105
LN-13	bottle	Glass	2.30E+04	1.00E+03	23.000	1	99.091	3.135

C2. Activity ratios of alpha emitting radionuclides and Ag-110m

Cm244/Ag110m

Sample ID	Waste Component	Waste Group	Cm244 (Bq/total)	Ag110m (Bq/total)	Cm244/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottles	Glass	1.50E+04	7.70E+04	0.195	1	0.909	-1.636
LN-ML	tool	Metal	5.50E+04	1.70E+04	3.235	1	2.727	1.174
LN-40	hose	Poly	1.50E+04	3.10E+03	4.839	1	4.545	1.577
LN-11	bottle	Glass	1.10E+04	8.80E+02	12.500	1	6.364	2.526
LN-26	bottle	Glass	4.60E+04	3.30E+03	13.939	1	8.182	2.635
LN-39	cell	Metal	8.30E+03	2.00E+02	41.500	1	10.000	3.726
LN-13	bottle	Glass	3.40E+03	4.60E+01	73.913	1	11.818	4.303
LN-44	cap	Metal	2.40E+04	2.60E+02	92.308	1	13.636	4.525
LN-36	cell	Metal	1.00E+04	5.40E+01	185.185	1	15.455	5.221
LN-19	bottle	Glass	4.20E+04	1.50E+02	280.000	1	17.273	5.635
LN-41	column	Metal	5.40E+04	1.60E+02	337.500	1	19.091	5.822
LN-9	bulb	Glass	2.10E+04	5.50E+01	381.818	1	20.909	5.945
LN-54	case	Metal	5.80E+04	1.50E+02	386.667	1	22.727	5.958
LN-7	tool	Metal	6.00E+04	1.50E+02	400.000	1	24.545	5.991
RH9F	Valve	Poly	2.00E+05	4.60E+02	434.783	1	26.364	6.075
LN-33	valve	Poly	1.90E+05	3.70E+02	513.514	1	28.182	6.241
RH9O	housing	Glass	6.00E+05	1.10E+03	545.455	1	30.000	6.302
LN-1	bottle	Glass	1.40E+06	2.20E+03	636.364	1	31.818	6.456
LN-46	can	Metal	3.30E+04	4.80E+01	687.500	1	33.636	6.533
LN-48	tool	Metal	4.90E+04	4.60E+01	1065.217	1	35.455	6.971
LN-6	bottle	Glass	9.30E+04	7.80E+01	1192.308	1	37.273	7.084
RH9G	Valve	Poly	2.80E+04	2.30E+01	1217.391	1	39.091	7.104
RH9H	Light Cord	Poly	1.00E+05	6.20E+01	1612.903	1	40.909	7.386
LN-4	bottle	Glass	2.00E+05	1.20E+02	1666.667	1	42.727	7.419
RH9I	MSM Boot	Poly	9.40E+04	4.70E+01	2000.000	1	44.545	7.601
RH9J	Lid	Poly	5.20E+04	2.20E+01	2363.636	1	46.364	7.768
RH9E	Valve	Poly	9.70E+04	3.90E+01	2487.179	1	48.182	7.819
LN-38	tool	Metal	5.30E+05	1.40E+02	3785.714	1	50.000	8.239
LN-49	socket	Metal	1.20E+05	3.10E+01	3870.968	1	51.818	8.261
LN-35	bottle	Poly	1.40E+06	3.50E+02	4000.000	1	53.636	8.294
RH9P	Tool	Metal	8.20E+04	1.90E+01	4315.789	1	55.455	8.370
RH9EE	Valve	Poly	5.90E+05	1.20E+02	4916.667	1	57.273	8.500
RH9M	bottle	Glass	1.50E+05	2.30E+01	6521.739	1	59.091	8.783
LN-8	bottle	Glass	3.80E+05	5.10E+01	7450.980	1	60.909	8.916
RH9LL	bottle	Glass	1.10E+06	1.20E+02	9166.667	1	62.727	9.123
RH9C	Melt	Poly	1.70E+05	1.10E+01	15454.545	1	64.545	9.646
RH9QQ	Wire	Metal	2.00E+06	1.10E+02	18181.818	1	66.364	9.808
LN-15	tool	Metal	1.10E+06	5.50E+01	20000.000	1	68.182	9.903
LN-28	bottle	Glass	1.10E+06	5.20E+01	21153.846	1	70.000	9.960
RH9A	Melt	Poly	1.80E+05	7.00E+00	25714.286	1	71.818	10.155
LN-3	bottle	Glass	1.40E+06	5.40E+01	25925.926	1	73.636	10.163
RH9L	bottle	Glass	3.40E+05	1.20E+01	28333.333	1	75.455	10.252
RH9N	glassware	Glass	9.00E+05	2.70E+01	33333.333	1	77.273	10.414
RH9Q	Wire	Metal	6.60E+05	1.70E+01	38823.529	1	79.091	10.567
RH9T	Wipes	Wipes	2.30E+06	5.00E+01	46000.000	1	80.909	10.736
RH9KK	Lid	Poly	3.80E+05	6.20E+00	61290.323	1	82.727	11.023
RH9D	bckt	Poly	1.30E+06	1.40E+01	92857.143	1	84.545	11.439
RH9K	Lid	Poly	1.40E+06	1.40E+01	100000.000	1	86.364	11.513
RH9S	Wipes	Wipes	2.30E+06	1.50E+01	153333.333	1	88.182	11.940
RH9R	Lid	Metal	1.60E+06	8.40E+00	190476.190	1	90.000	12.157
RH9SS	Wipes	Wipes	2.80E+06	1.00E+01	280,000.000	1	91.818	12.543
RH9V	Wipes	Wipes	9.40E+06	2.60E+01	361,538.462	1	93.636	12.798
RH9U	Wipes	Wipes	1.30E+07	7.00E+00	1,857,142.857	1	95.455	14.435
LN-25	bottle	Glass	1.20E+08	3.40E+01	3,529,411.765	1	97.273	15.077
RH9AA	Melt	Poly	6.90E+07	5.70E+00	12,105,263.158	1	99.091	16.309

Pu238/Ag110m

Sample ID	Waste Component	Waste Group	Pu238 (Bq/total)	Ag110m (Bq/total)	Pu238/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9O	housing	Glass	5.25E+01	1.10E+03	0.048	1	0.909	-3.042
LN-40	hose	Poly	3.80E+02	3.10E+03	0.123	1	2.727	-2.099
LN-1	bottle	Glass	4.70E+02	2.20E+03	0.214	1	4.545	-1.543
LN-26	bottle	Glass	1.10E+03	3.30E+03	0.333	1	6.364	-1.099
RH9H	Light Cord	Poly	2.90E+01	6.20E+01	0.468	1	8.182	-0.760
RH9I	MSM Boot	Poly	3.50E+01	4.70E+01	0.745	1	10.000	-0.295
RH9LL	bottle	Glass	1.20E+02	1.20E+02	1.000	1	11.818	0.000
LN-11	bottle	Glass	1.30E+03	8.80E+02	1.477	1	13.636	0.390
RH9F	Valve	Poly	1.00E+03	4.60E+02	2.174	1	15.455	0.777
LN-GL	bottles	Glass	2.70E+05	7.70E+04	3.506	1	17.273	1.255
RH9M	bottle	Glass	1.00E+02	2.30E+01	4.348	1	19.091	1.470
LN-38	tool	Metal	6.90E+02	1.40E+02	4.929	1	20.909	1.595
LN-19	bottle	Glass	1.10E+03	1.50E+02	7.333	1	22.727	1.992
RH9E	Valve	Poly	3.00E+02	3.90E+01	7.692	1	24.545	2.040
RH9T	Wipes	Wipes	3.90E+02	5.00E+01	7.800	1	26.364	2.054
LN-4	bottle	Glass	9.80E+02	1.20E+02	8.167	1	28.182	2.100
LN-54	case	Metal	1.40E+03	1.50E+02	9.333	1	30.000	2.234
RH9SS	Wipes	Wipes	1.10E+02	1.00E+01	11.000	1	31.818	2.398
LN-44	cap	Metal	3.10E+03	2.60E+02	11.923	1	33.636	2.478
LN-9	bulb	Glass	6.60E+02	5.50E+01	12.000	1	35.455	2.485
RH9J	Lid	Poly	2.70E+02	2.20E+01	12.273	1	37.273	2.507
LN-41	column	Metal	2.00E+03	1.60E+02	12.500	1	39.091	2.526
LN-49	socket	Metal	4.00E+02	3.10E+01	12.903	1	40.909	2.557
LN-25	bottle	Glass	4.40E+02	3.40E+01	12.941	1	42.727	2.560
RH9V	Wipes	Wipes	3.60E+02	2.60E+01	13.846	1	44.545	2.628
LN-39	cell	Metal	3.00E+03	2.00E+02	15.000	1	46.364	2.708
LN-8	bottle	Glass	7.90E+02	5.10E+01	15.490	1	48.182	2.740
LN-33	valve	Poly	6.40E+03	3.70E+02	17.297	1	50.000	2.851
RH9QQ	Wire	Metal	1.95E+03	1.10E+02	17.727	1	51.818	2.875
RH9A	Melt	Poly	1.30E+02	7.00E+00	18.571	1	53.636	2.922
LN-6	bottle	Glass	1.70E+03	7.80E+01	21.795	1	55.455	3.082
RH9U	Wipes	Wipes	1.55E+02	7.00E+00	22.143	1	57.273	3.098
LN-7	tool	Metal	3.40E+03	1.50E+02	22.667	1	59.091	3.121
LN-46	can	Metal	1.10E+03	4.80E+01	22.917	1	60.909	3.132
LN-13	bottle	Glass	1.10E+03	4.60E+01	23.913	1	62.727	3.174
LN-3	bottle	Glass	1.40E+03	5.40E+01	25.926	1	64.545	3.255
LN-28	bottle	Glass	1.40E+03	5.20E+01	26.923	1	66.364	3.293
RH9R	Lid	Metal	2.40E+02	8.40E+00	28.571	1	68.182	3.352
RH9AA	Melt	Poly	1.70E+02	5.70E+00	29.825	1	70.000	3.395
RH9D	bckt	Poly	4.85E+02	1.40E+01	34.643	1	71.818	3.545
LN-48	tool	Metal	1.60E+03	4.60E+01	34.783	1	73.636	3.549
RH9G	Valve	Poly	8.00E+02	2.30E+01	34.783	1	75.455	3.549
RH9C	Melt	Poly	4.20E+02	1.10E+01	38.182	1	77.273	3.642
LN-35	bottle	Poly	1.40E+04	3.50E+02	40.000	1	79.091	3.689
RH9L	bottle	Glass	5.00E+02	1.20E+01	41.667	1	80.909	3.730
LN-36	cell	Metal	2.30E+03	5.40E+01	42.593	1	82.727	3.752
RH9K	Lid	Poly	6.80E+02	1.40E+01	48.571	1	84.545	3.883
RH9Q	Wire	Metal	8.75E+02	1.70E+01	51.471	1	86.364	3.941
RH9EE	Valve	Poly	6.20E+03	1.20E+02	51.667	1	88.182	3.945
RH9P	Tool	Metal	9.90E+02	1.90E+01	52.105	1	90.000	3.953
LN-ML	tool	Metal	1.10E+06	1.70E+04	64.706	1	91.818	4.170
RH9N	glassware	Glass	1.95E+03	2.70E+01	72.222	1	93.636	4.280
RH9S	Wipes	Wipes	1.50E+03	1.50E+01	100.000	1	95.455	4.605
LN-15	tool	Metal	6.30E+03	5.50E+01	114.545	1	97.273	4.741
RH9KK	Lid	Poly	8.50E+02	6.20E+00	137.097	1	99.091	4.921

Pu*/Ag110m

Sample ID	Waste Component	Waste Group	Pu* (Bq/total)	Ag110m (Bq/total)	Pu*/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-ML	tool	Wipes	1.55E+02	1.70E+04	0.009	1	0.909	-4.698
LN-1	bottle	Poly	2.90E+02	2.20E+03	0.132	1	2.727	-2.026
LN-26	bottle	Metal	4.80E+02	3.30E+03	0.145	1	4.545	-1.928
LN-40	hose	Glass	4.60E+02	3.10E+03	0.148	1	6.364	-1.908
LN-39	cell	Poly	5.80E+01	2.00E+02	0.290	1	8.182	-1.238
LN-11	bottle	Glass	5.10E+02	8.80E+02	0.580	1	10.000	-0.546
RH9F	Valve	Poly	5.00E+02	4.60E+02	1.087	1	11.818	0.083
LN-33	valve	Poly	4.85E+02	3.70E+02	1.311	1	13.636	0.271
LN-35	bottle	Poly	5.20E+02	3.50E+02	1.486	1	15.455	0.396
LN-9	bulb	Poly	1.10E+02	5.50E+01	2.000	1	17.273	0.693
LN-3	bottle	Wipes	1.20E+02	5.40E+01	2.222	1	19.091	0.799
LN-41	column	Metal	4.00E+02	1.60E+02	2.500	1	20.909	0.916
LN-13	bottle	Glass	1.20E+02	4.60E+01	2.609	1	22.727	0.959
LN-46	can	Wipes	1.50E+02	4.80E+01	3.125	1	24.545	1.139
RH9EE	Valve	Metal	4.00E+02	1.20E+02	3.333	1	26.364	1.204
RH9O	housing	Glass	4.00E+03	1.10E+03	3.636	1	28.182	1.291
LN-GL	bottles	Metal	2.90E+05	7.70E+04	3.766	1	30.000	1.326
LN-54	case	Poly	6.20E+02	1.50E+02	4.133	1	31.818	1.419
RH9H	Light Cord	Poly	2.60E+02	6.20E+01	4.194	1	33.636	1.434
LN-44	cap	Metal	1.10E+03	2.60E+02	4.231	1	35.455	1.442
LN-48	tool	Poly	2.50E+02	4.60E+01	5.435	1	37.273	1.693
LN-38	tool	Metal	9.30E+02	1.40E+02	6.643	1	39.091	1.894
LN-8	bottle	Wipes	3.50E+02	5.10E+01	6.863	1	40.909	1.926
LN-6	bottle	Metal	5.70E+02	7.80E+01	7.308	1	42.727	1.989
RH9N	glassware	Poly	2.60E+02	2.70E+01	9.630	1	44.545	2.265
RH9I	MSM Boot	Poly	5.15E+02	4.70E+01	10.957	1	46.364	2.394
LN-49	socket	Glass	4.00E+02	3.10E+01	12.903	1	48.182	2.557
RH9A	Melt	Poly	9.10E+01	7.00E+00	13.000	1	50.000	2.565
LN-28	bottle	Metal	6.80E+02	5.20E+01	13.077	1	51.818	2.571
LN-19	bottle	Glass	2.00E+03	1.50E+02	13.333	1	53.636	2.590
RH9LL	bottle	Metal	1.80E+03	1.20E+02	15.000	1	55.455	2.708
RH9G	Valve	Poly	3.50E+02	2.30E+01	15.217	1	57.273	2.722
RH9S	Wipes	Wipes	2.90E+02	1.50E+01	19.333	1	59.091	2.962
RH9E	Valve	Metal	9.50E+02	3.90E+01	24.359	1	60.909	3.193
LN-7	tool	Glass	4.00E+03	1.50E+02	26.667	1	62.727	3.283
RH9C	Melt	Glass	3.00E+02	1.10E+01	27.273	1	64.545	3.306
RH9D	bckt	Poly	4.40E+02	1.40E+01	31.429	1	66.364	3.448
RH9KK	Lid	Metal	2.15E+02	6.20E+00	34.677	1	68.182	3.546
LN-36	cell	Metal	2.10E+03	5.40E+01	38.889	1	70.000	3.661
RH9J	Lid	Glass	1.10E+03	2.20E+01	50.000	1	71.818	3.912
RH9QQ	Wire	Glass	6.30E+03	1.10E+02	57.273	1	73.636	4.048
LN-4	bottle	Glass	6.90E+03	1.20E+02	57.500	1	75.455	4.052
LN-25	bottle	Poly	3.60E+03	3.40E+01	105.882	1	77.273	4.662
RH9L	bottle	Metal	1.40E+03	1.20E+01	116.667	1	79.091	4.759
RH9U	Wipes	Metal	8.75E+02	7.00E+00	125.000	1	80.909	4.828
RH9T	Wipes	Glass	6.30E+03	5.00E+01	126.000	1	82.727	4.836
RH9AA	Melt	Glass	1.10E+03	5.70E+00	192.982	1	84.545	5.263
RH9M	bottle	Glass	4.90E+03	2.30E+01	213.043	1	86.364	5.361
RH9P	Tool	Glass	4.70E+03	1.90E+01	247.368	1	88.182	5.511
RH9V	Wipes	Glass	8.90E+03	2.60E+01	342.308	1	90.000	5.836
RH9Q	Wire	Metal	6.20E+03	1.70E+01	364.706	1	91.818	5.899
RH9SS	Wipes	Metal	3.80E+03	1.00E+01	380.000	1	93.636	5.940
RH9K	Lid	Poly	5.50E+03	1.40E+01	392.857	1	95.455	5.973
RH9R	Lid	Glass	6.60E+03	8.40E+00	785.714	1	97.273	6.667
LN-15	tool	Glass	3.20E+05	5.50E+01	5,818.182	1	99.091	8.669

Pu242/Ag110m

Sample ID	Waste Component	Waste Group	Pu242 (Bq/total)	Ag110m (Bq/total)	Pu242/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	8.70E+00	3.10E+03	0.003	1	0.909	-5.876
LN-1	bottle	Glass	2.00E+01	2.20E+03	0.009	1	2.727	-4.700
LN-26	bottle	Glass	6.50E+01	3.30E+03	0.020	1	4.545	-3.927
LN-11	bottle	Glass	2.00E+01	8.80E+02	0.023	1	6.364	-3.784
LN-39	cell	Metal	9.30E+00	2.00E+02	0.047	1	8.182	-3.068
RH9O	housing	Glass	5.25E+01	1.10E+03	0.048	1	10.000	-3.042
LN-GL	bottles	Glass	4.20E+03	7.70E+04	0.055	1	11.818	-2.909
LN-33	valve	Poly	5.00E+01	3.70E+02	0.135	1	13.636	-2.001
LN-4	bottle	Glass	2.00E+01	1.20E+02	0.167	1	15.455	-1.792
LN-44	cap	Metal	4.60E+01	2.60E+02	0.177	1	17.273	-1.732
LN-38	tool	Metal	2.80E+01	1.40E+02	0.200	1	19.091	-1.609
LN-6	bottle	Glass	1.60E+01	7.80E+01	0.205	1	20.909	-1.584
LN-41	column	Metal	3.30E+01	1.60E+02	0.206	1	22.727	-1.579
LN-19	bottle	Glass	3.20E+01	1.50E+02	0.213	1	24.545	-1.545
LN-54	case	Metal	3.40E+01	1.50E+02	0.227	1	26.364	-1.484
LN-25	bottle	Glass	8.00E+00	3.40E+01	0.235	1	28.182	-1.447
LN-3	bottle	Glass	1.50E+01	5.40E+01	0.278	1	30.000	-1.281
LN-48	tool	Metal	1.30E+01	4.60E+01	0.283	1	31.818	-1.264
LN-7	tool	Metal	4.80E+01	1.50E+02	0.320	1	33.636	-1.139
LN-46	can	Metal	1.70E+01	4.80E+01	0.354	1	35.455	-1.038
LN-13	bottle	Glass	2.00E+01	4.60E+01	0.435	1	37.273	-0.833
LN-36	cell	Metal	2.40E+01	5.40E+01	0.444	1	39.091	-0.811
LN-35	bottle	Poly	2.00E+02	3.50E+02	0.571	1	40.909	-0.560
LN-9	bulb	Glass	3.90E+01	5.50E+01	0.709	1	42.727	-0.344
LN-ML	tool	Metal	1.30E+04	1.70E+04	0.765	1	44.545	-0.268
LN-8	bottle	Glass	4.40E+01	5.10E+01	0.863	1	46.364	-0.148
LN-28	bottle	Glass	4.90E+01	5.20E+01	0.942	1	48.182	-0.059
RH9LL	bottle	Glass	1.20E+02	1.20E+02	1.000	1	50.000	0.000
LN-15	tool	Metal	6.60E+01	5.50E+01	1.200	1	51.818	0.182
RH9F	Valve	Poly	1.00E+03	4.60E+02	2.174	1	53.636	0.777
LN-49	socket	Metal	8.20E+01	3.10E+01	2.645	1	55.455	0.973
RH9T	Wipes	Wipes	1.65E+02	5.00E+01	3.300	1	57.273	1.194
RH9E	Valve	Poly	2.60E+02	3.90E+01	6.667	1	59.091	1.897
RH9H	Light Cord	Poly	5.15E+02	6.20E+01	8.306	1	60.909	2.117
RH9G	Valve	Poly	2.90E+02	2.30E+01	12.609	1	62.727	2.534
RH9I	MSM Boot	Poly	6.35E+02	4.70E+01	13.511	1	64.545	2.603
RH9A	Melt	Poly	1.10E+02	7.00E+00	15.714	1	66.364	2.755
RH9AA	Melt	Poly	9.10E+01	5.70E+00	15.965	1	68.182	2.770
RH9QQ	Wire	Metal	1.95E+03	1.10E+02	17.727	1	70.000	2.875
RH9U	Wipes	Wipes	1.55E+02	7.00E+00	22.143	1	71.818	3.098
RH9V	Wipes	Wipes	5.85E+02	2.60E+01	22.500	1	73.636	3.114
RH9J	Lid	Poly	5.20E+02	2.20E+01	23.636	1	75.455	3.163
RH9R	Lid	Metal	2.15E+02	8.40E+00	25.595	1	77.273	3.242
RH9C	Melt	Poly	3.50E+02	1.10E+01	31.818	1	79.091	3.460
RH9D	bckt	Poly	4.85E+02	1.40E+01	34.643	1	80.909	3.545
RH9M	bottle	Glass	1.00E+03	2.30E+01	43.478	1	82.727	3.772
RH9L	bottle	Glass	6.00E+02	1.20E+01	50.000	1	84.545	3.912
RH9Q	Wire	Metal	8.75E+02	1.70E+01	51.471	1	86.364	3.941
RH9EE	Valve	Poly	6.20E+03	1.20E+02	51.667	1	88.182	3.945
RH9P	Tool	Metal	9.90E+02	1.90E+01	52.105	1	90.000	3.953
RH9SS	Wipes	Wipes	6.10E+02	1.00E+01	61.000	1	91.818	4.111
RH9N	glassware	Glass	1.95E+03	2.70E+01	72.222	1	93.636	4.280
RH9K	Lid	Poly	1.10E+03	1.40E+01	78.571	1	95.455	4.364
RH9KK	Lid	Poly	5.75E+02	6.20E+00	92.742	1	97.273	4.530
RH9S	Wipes	Wipes	1.50E+03	1.50E+01	100.000	1	99.091	4.605

Am241/Ag110m

Sample ID	Waste Component	Waste Group	Am241 (Bq/total)	Ag110m (Bq/total)	Am241/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9O	housing	Glass	5.40E+01	1.10E+03	0.049	1	0.909	-3.014
LN-26	bottle	Glass	1.70E+03	3.30E+03	0.515	1	2.727	-0.663
RH9F	Valve	Poly	4.60E+02	4.60E+02	1.000	1	4.545	0.000
RH9T	Wipes	Wipes	8.70E+01	5.00E+01	1.740	1	6.364	0.554
LN-1	bottle	Glass	7.30E+03	2.20E+03	3.318	1	8.182	1.199
LN-40	hose	Poly	1.10E+04	3.10E+03	3.548	1	10.000	1.266
RH9G	Valve	Poly	1.60E+02	2.30E+01	6.957	1	11.818	1.940
LN-11	bottle	Glass	6.20E+03	8.80E+02	7.045	1	13.636	1.952
RH9LL	bottle	Glass	8.50E+02	1.20E+02	7.083	1	15.455	1.958
LN-GL	bottles	Glass	6.20E+05	7.70E+04	8.052	1	17.273	2.086
LN-44	cap	Metal	2.20E+03	2.60E+02	8.462	1	19.091	2.136
RH9E	Valve	Poly	3.50E+02	3.90E+01	8.974	1	20.909	2.194
LN-38	tool	Metal	1.70E+03	1.40E+02	12.143	1	22.727	2.497
LN-19	bottle	Glass	1.90E+03	1.50E+02	12.667	1	24.545	2.539
RH9H	Light Cord	Poly	9.40E+02	6.20E+01	15.161	1	26.364	2.719
LN-7	tool	Metal	2.50E+03	1.50E+02	16.667	1	28.182	2.813
LN-4	bottle	Glass	2.20E+03	1.20E+02	18.333	1	30.000	2.909
RH9I	MSM Boot	Poly	9.10E+02	4.70E+01	19.362	1	31.818	2.963
RH9EE	Valve	Poly	2.80E+03	1.20E+02	23.333	1	33.636	3.150
RH9R	Lid	Metal	2.20E+02	8.40E+00	26.190	1	35.455	3.265
LN-9	bulb	Glass	1.50E+03	5.50E+01	27.273	1	37.273	3.306
LN-49	socket	Metal	8.90E+02	3.10E+01	28.710	1	39.091	3.357
RH9V	Wipes	Wipes	7.60E+02	2.60E+01	29.231	1	40.909	3.375
RH9AA	Melt	Poly	1.70E+02	5.70E+00	29.825	1	42.727	3.395
RH9A	Melt	Poly	2.20E+02	7.00E+00	31.429	1	44.545	3.448
RH9J	Lid	Poly	7.20E+02	2.20E+01	32.727	1	46.364	3.488
LN-54	case	Metal	5.20E+03	1.50E+02	34.667	1	48.182	3.546
RH9KK	Lid	Poly	2.50E+02	6.20E+00	40.323	1	50.000	3.697
LN-33	valve	Poly	1.50E+04	3.70E+02	40.541	1	51.818	3.702
LN-46	can	Metal	2.00E+03	4.80E+01	41.667	1	53.636	3.730
LN-28	bottle	Glass	2.20E+03	5.20E+01	42.308	1	55.455	3.745
LN-41	column	Metal	7.20E+03	1.60E+02	45.000	1	57.273	3.807
RH9U	Wipes	Wipes	3.20E+02	7.00E+00	45.714	1	59.091	3.822
LN-3	bottle	Glass	2.50E+03	5.40E+01	46.296	1	60.909	3.835
RH9QQ	Wire	Metal	5.60E+03	1.10E+02	50.909	1	62.727	3.930
LN-ML	tool	Metal	9.30E+05	1.70E+04	54.706	1	64.545	4.002
LN-13	bottle	Glass	2.80E+03	4.60E+01	60.870	1	66.364	4.109
RH9M	bottle	Glass	1.40E+03	2.30E+01	60.870	1	68.182	4.109
RH9SS	Wipes	Wipes	6.20E+02	1.00E+01	62.000	1	70.000	4.127
LN-8	bottle	Glass	3.20E+03	5.10E+01	62.745	1	71.818	4.139
RH9C	Melt	Poly	7.40E+02	1.10E+01	67.273	1	73.636	4.209
RH9L	bottle	Glass	8.20E+02	1.20E+01	68.333	1	75.455	4.224
RH9D	bckt	Poly	1.00E+03	1.40E+01	71.429	1	77.273	4.269
LN-48	tool	Metal	3.70E+03	4.60E+01	80.435	1	79.091	4.387
LN-6	bottle	Glass	7.10E+03	7.80E+01	91.026	1	80.909	4.511
RH9K	Lid	Poly	1.30E+03	1.40E+01	92.857	1	82.727	4.531
LN-15	tool	Metal	5.90E+03	5.50E+01	107.273	1	84.545	4.675
RH9P	Tool	Metal	2.20E+03	1.90E+01	115.789	1	86.364	4.752
RH9S	Wipes	Wipes	2.10E+03	1.50E+01	140.000	1	88.182	4.942
LN-25	bottle	Glass	4.90E+03	3.40E+01	144.118	1	90.000	4.971
LN-35	bottle	Poly	5.80E+04	3.50E+02	165.714	1	91.818	5.110
RH9Q	Wire	Metal	3.00E+03	1.70E+01	176.471	1	93.636	5.173
RH9N	glassware	Glass	1.10E+04	2.70E+01	407.407	1	95.455	6.010
LN-39	cell	Metal	1.10E+05	2.00E+02	550.000	1	97.273	6.310
LN-36	cell	Metal	8.30E+04	5.40E+01	1.537.037	1	99.091	7.338

Am243/Ag110m

Sample ID	Waste Component	Waste Group	Am243 (Bq/total)	Ag110m (Bq/total)	Am243/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9O	housing	Glass	4.00E+00	1.10E+03	0.004	1	0.909	-5.617
RH9F	Valve	Poly	2.40E+01	4.60E+02	0.052	1	2.727	-2.953
LN-26	bottle	Glass	2.40E+02	3.30E+03	0.073	1	4.545	-2.621
RH9T	Wipes	Wipes	7.50E+00	5.00E+01	0.150	1	6.364	-1.897
LN-1	bottle	Glass	4.50E+02	2.20E+03	0.205	1	8.182	-1.587
RH9LL	bottle	Glass	4.20E+01	1.20E+02	0.350	1	10.000	-1.050
RH9G	Valve	Poly	8.90E+00	2.30E+01	0.387	1	11.818	-0.949
LN-11	bottle	Glass	4.10E+02	8.80E+02	0.466	1	13.636	-0.764
LN-7	tool	Metal	8.00E+01	1.50E+02	0.533	1	15.455	-0.629
RH9A	Melt	Poly	5.10E+00	7.00E+00	0.729	1	17.273	-0.317
LN-44	cap	Metal	1.90E+02	2.60E+02	0.731	1	19.091	-0.314
RH9H	Light Cord	Poly	4.60E+01	6.20E+01	0.742	1	20.909	-0.298
RH9E	Valve	Poly	3.20E+01	3.90E+01	0.821	1	22.727	-0.198
RH9I	MSM Boot	Poly	4.20E+01	4.70E+01	0.894	1	24.545	-0.112
LN-GL	bottles	Glass	7.10E+04	7.70E+04	0.922	1	26.364	-0.081
LN-19	bottle	Glass	1.40E+02	1.50E+02	0.933	1	28.182	-0.069
LN-35	bottle	Poly	3.70E+02	3.50E+02	1.057	1	30.000	0.056
RH9QQ	Wire	Metal	1.20E+02	1.10E+02	1.091	1	31.818	0.087
RH9U	Wipes	Wipes	8.00E+00	7.00E+00	1.143	1	33.636	0.134
RH9R	Lid	Metal	1.00E+01	8.40E+00	1.190	1	35.455	0.174
LN-38	tool	Metal	1.70E+02	1.40E+02	1.214	1	37.273	0.194
LN-41	column	Metal	2.10E+02	1.60E+02	1.313	1	39.091	0.272
RH9J	Lid	Poly	2.90E+01	2.20E+01	1.318	1	40.909	0.276
RH9EE	Valve	Poly	2.10E+02	1.20E+02	1.750	1	42.727	0.560
RH9KK	Lid	Poly	1.10E+01	6.20E+00	1.774	1	44.545	0.573
LN-40	hose	Poly	5.80E+03	3.10E+03	1.871	1	46.364	0.626
RH9C	Melt	Poly	2.10E+01	1.10E+01	1.909	1	48.182	0.647
RH9AA	Melt	Poly	1.10E+01	5.70E+00	1.930	1	50.000	0.657
RH9D	bckt	Poly	2.80E+01	1.40E+01	2.000	1	51.818	0.693
LN-54	case	Metal	3.20E+02	1.50E+02	2.133	1	53.636	0.758
LN-46	can	Metal	1.10E+02	4.80E+01	2.292	1	55.455	0.829
RH9Q	Wire	Metal	4.30E+01	1.70E+01	2.529	1	57.273	0.928
RH9V	Wipes	Wipes	6.90E+01	2.60E+01	2.654	1	59.091	0.976
RH9L	bottle	Glass	3.40E+01	1.20E+01	2.833	1	60.909	1.041
LN-49	socket	Metal	8.80E+01	3.10E+01	2.839	1	62.727	1.043
LN-ML	tool	Metal	4.90E+04	1.70E+04	2.882	1	64.545	1.059
LN-48	tool	Metal	1.50E+02	4.60E+01	3.261	1	66.364	1.182
LN-4	bottle	Glass	4.10E+02	1.20E+02	3.417	1	68.182	1.229
LN-33	valve	Poly	1.30E+03	3.70E+02	3.514	1	70.000	1.257
RH9SS	Wipes	Wipes	3.60E+01	1.00E+01	3.600	1	71.818	1.281
RH9N	glassware	Glass	1.00E+02	2.70E+01	3.704	1	73.636	1.309
RH9M	bottle	Glass	8.90E+01	2.30E+01	3.870	1	75.455	1.353
RH9P	Tool	Metal	9.60E+01	1.90E+01	5.053	1	77.273	1.620
LN-15	tool	Metal	2.90E+02	5.50E+01	5.273	1	79.091	1.663
LN-28	bottle	Glass	2.90E+02	5.20E+01	5.577	1	80.909	1.719
LN-9	bulb	Glass	3.10E+02	5.50E+01	5.636	1	82.727	1.729
RH9K	Lid	Poly	8.10E+01	1.40E+01	5.786	1	84.545	1.755
LN-39	cell	Metal	1.20E+03	2.00E+02	6.000	1	86.364	1.792
LN-25	bottle	Glass	2.20E+02	3.40E+01	6.471	1	88.182	1.867
LN-13	bottle	Glass	3.00E+02	4.60E+01	6.522	1	90.000	1.875
LN-8	bottle	Glass	3.70E+02	5.10E+01	7.255	1	91.818	1.982
LN-6	bottle	Glass	6.80E+02	7.80E+01	8.718	1	93.636	2.165
LN-3	bottle	Glass	5.70E+02	5.40E+01	10.556	1	95.455	2.357
LN-36	cell	Metal	1.00E+03	5.40E+01	18.519	1	97.273	2.919
RH9S	Wipes	Wipes	3.20E+02	1.50E+01	21.333	1	99.091	3.060

Cf252/Ag110m

Sample ID	Waste Component	Waste Group	Cf252 (Bq/total)	Ag110m (Bq/total)	Cf252/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9O	housing	Glass	1.40E+03	1.10E+03	1.273	1	0.909	0.241
RH9LL	bottle	Glass	1.80E+02	1.20E+02	1.500	1	2.727	0.405
LN-26	bottle	Glass	5.80E+03	3.30E+03	1.758	1	4.545	0.564
RH9F	Valve	Poly	8.10E+02	4.60E+02	1.761	1	6.364	0.566
RH9T	Wipes	Wipes	2.00E+02	5.00E+01	4.000	1	8.182	1.386
LN-44	cap	Metal	1.20E+03	2.60E+02	4.615	1	10.000	1.529
LN-40	hose	Poly	1.80E+04	3.10E+03	5.806	1	11.818	1.759
LN-11	bottle	Glass	5.50E+03	8.80E+02	6.250	1	13.636	1.833
RH9G	Valve	Poly	1.50E+02	2.30E+01	6.522	1	15.455	1.875
LN-1	bottle	Glass	1.60E+04	2.20E+03	7.273	1	17.273	1.984
RH9H	Light Cord	Poly	7.00E+02	6.20E+01	11.290	1	19.091	2.424
LN-38	tool	Metal	1.90E+03	1.40E+02	13.571	1	20.909	2.608
LN-19	bottle	Glass	2.10E+03	1.50E+02	14.000	1	22.727	2.639
LN-54	case	Metal	2.50E+03	1.50E+02	16.667	1	24.545	2.813
LN-GL	bottles	Glass	1.30E+06	7.70E+04	16.883	1	26.364	2.826
RH9E	Valve	Poly	7.20E+02	3.90E+01	18.462	1	28.182	2.916
RH9I	MSM Boot	Poly	9.40E+02	4.70E+01	20.000	1	30.000	2.996
LN-4	bottle	Glass	2.50E+03	1.20E+02	20.833	1	31.818	3.037
LN-49	socket	Metal	7.80E+02	3.10E+01	25.161	1	33.636	3.225
RH9EE	Valve	Poly	3.10E+03	1.20E+02	25.833	1	35.455	3.252
LN-39	cell	Metal	5.20E+03	2.00E+02	26.000	1	37.273	3.258
RH9S	Wipes	Wipes	3.90E+02	1.50E+01	26.000	1	39.091	3.258
LN-9	bulb	Glass	1.60E+03	5.50E+01	29.091	1	40.909	3.370
RH9QQ	Wire	Metal	3.40E+03	1.10E+02	30.909	1	42.727	3.431
LN-7	tool	Metal	4.80E+03	1.50E+02	32.000	1	44.545	3.466
LN-25	bottle	Glass	1.10E+03	3.40E+01	32.353	1	46.364	3.477
LN-33	valve	Poly	1.30E+04	3.70E+02	35.135	1	48.182	3.559
LN-41	column	Metal	6.00E+03	1.60E+02	37.500	2	51.818	3.624
LN-46	can	Metal	1.80E+03	4.80E+01	37.500	0	51.818	3.624
RH9A	Melt	Poly	2.80E+02	7.00E+00	40.000	1	53.636	3.689
RH9AA	Melt	Poly	2.30E+02	5.70E+00	40.351	1	55.455	3.698
LN-28	bottle	Glass	2.10E+03	5.20E+01	40.385	1	57.273	3.698
LN-6	bottle	Glass	3.20E+03	7.80E+01	41.026	1	59.091	3.714
RH9U	Wipes	Wipes	3.20E+02	7.00E+00	45.714	1	60.909	3.822
RH9R	Lid	Metal	3.90E+02	8.40E+00	46.429	1	62.727	3.838
LN-3	bottle	Glass	2.60E+03	5.40E+01	48.148	1	64.545	3.874
RH9Q	Wire	Metal	8.40E+02	1.70E+01	49.412	1	66.364	3.900
LN-13	bottle	Glass	2.50E+03	4.60E+01	54.348	1	68.182	3.995
LN-48	tool	Metal	2.50E+03	4.60E+01	54.348	1	70.000	3.995
LN-8	bottle	Glass	2.80E+03	5.10E+01	54.902	1	71.818	4.006
LN-35	bottle	Poly	2.10E+04	3.50E+02	60.000	2	75.455	4.094
RH9C	Melt	Poly	6.60E+02	1.10E+01	60.000	0	75.455	4.094
RH9D	bckt	Poly	8.80E+02	1.40E+01	62.857	1	77.273	4.141
RH9P	Tool	Metal	1.20E+03	1.90E+01	63.158	1	79.091	4.146
RH9V	Wipes	Wipes	2.10E+03	2.60E+01	80.769	1	80.909	4.392
LN-36	cell	Metal	4.50E+03	5.40E+01	83.333	1	82.727	4.423
RH9N	glassware	Glass	2.90E+03	2.70E+01	107.407	1	84.545	4.677
LN-ML	tool	Metal	2.00E+06	1.70E+04	117.647	1	86.364	4.768
RH9SS	Wipes	Wipes	1.20E+03	1.00E+01	120.000	1	88.182	4.787
RH9M	bottle	Glass	3.20E+03	2.30E+01	139.130	1	90.000	4.935
RH9L	bottle	Glass	1.90E+03	1.20E+01	158.333	1	91.818	5.065
LN-15	tool	Metal	1.00E+04	5.50E+01	181.818	1	93.636	5.203
RH9K	Lid	Poly	3.10E+03	1.40E+01	221.429	1	95.455	5.400
RH9J	Lid	Poly	7.10E+03	2.20E+01	322.727	1	97.273	5.777
RH9KK	Lid	Poly	2.70E+03	6.20E+00	435.484	1	99.091	6.076

Cm242/Ag110m

Sample ID	Waste Component	Waste Group	Cm242 (Bq/total)	Ag110m (Bq/total)	Cm242/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottle	Glass	3.10E+03	7.70E+04	0.040	1	0.909	-3.212
LN-ML	Wipes	Wipes	7.30E+02	1.70E+04	0.043	1	2.727	-3.148
LN-11	bottle	Glass	1.20E+02	8.80E+02	0.136	1	4.545	-1.992
LN-40	tool	Metal	1.50E+03	3.10E+03	0.484	1	6.364	-0.726
LN-26	column	Metal	1.70E+03	3.30E+03	0.515	1	8.182	-0.663
LN-7	Melt	Poly	1.70E+02	1.50E+02	1.133	1	10.000	0.125
LN-13	housing	Glass	5.30E+01	4.60E+01	1.152	1	11.818	0.142
RH9O	bottle	Glass	1.30E+03	1.10E+03	1.182	1	13.636	0.167
LN-41	Wipes	Wipes	2.10E+02	1.60E+02	1.313	1	15.455	0.272
RH9EE	Melt	Poly	1.90E+02	1.20E+02	1.583	1	17.273	0.460
LN-35	bottle	Glass	6.10E+02	3.50E+02	1.743	1	19.091	0.556
LN-19	can	Metal	3.20E+02	1.50E+02	2.133	1	20.909	0.758
LN-54	Light Cord	Poly	4.30E+02	1.50E+02	2.867	1	22.727	1.053
LN-46	Valve	Poly	1.70E+02	4.80E+01	3.542	1	24.545	1.265
LN-49	Valve	Poly	1.10E+02	3.10E+01	3.548	1	26.364	1.266
RH9F	bottle	Glass	2.30E+03	4.60E+02	5.000	1	28.182	1.609
LN-38	bckt	Poly	8.00E+02	1.40E+02	5.714	1	30.000	1.743
LN-28	socket	Metal	3.00E+02	5.20E+01	5.769	1	31.818	1.753
LN-1	hose	Poly	1.30E+04	2.20E+03	5.909	1	33.636	1.776
LN-39	tool	Metal	1.40E+03	2.00E+02	7.000	1	35.455	1.946
LN-4	bottle	Glass	1.20E+03	1.20E+02	10.000	1	37.273	2.303
LN-9	Valve	Poly	5.90E+02	5.50E+01	10.727	1	39.091	2.373
RH9E	Melt	Poly	5.30E+02	3.90E+01	13.590	1	40.909	2.609
RH9J	Lid	Metal	3.40E+02	2.20E+01	15.455	1	42.727	2.738
RH9A	Wipes	Wipes	1.50E+02	7.00E+00	21.429	1	44.545	3.065
LN-33	valve	Poly	9.40E+03	3.70E+02	25.405	1	46.364	3.235
RH9T	Wire	Metal	1.60E+03	5.00E+01	32.000	1	48.182	3.466
LN-8	Lid	Poly	2.20E+03	5.10E+01	43.137	1	50.000	3.764
RH9I	bottle	Glass	2.10E+03	4.70E+01	44.681	1	51.818	3.800
LN-36	bottle	Glass	2.70E+03	5.40E+01	50.000	1	53.636	3.912
LN-48	case	Metal	2.30E+03	4.60E+01	50.000	1	55.455	3.912
RH9AA	Wipes	Wipes	2.90E+02	5.70E+00	50.877	1	57.273	3.929
RH9LL	bulb	Glass	6.40E+03	1.20E+02	53.333	1	59.091	3.977
RH9K	Tool	Metal	8.00E+02	1.40E+01	57.143	1	60.909	4.046
RH9H	bottle	Glass	3.60E+03	6.20E+01	58.065	1	62.727	4.062
LN-44	bottle	Glass	1.60E+04	2.60E+02	61.538	1	64.545	4.120
RH9D	Wipes	Wipes	9.50E+02	1.40E+01	67.857	1	66.364	4.217
RH9C	MSM Boot	Poly	7.60E+02	1.10E+01	69.091	1	68.182	4.235
LN-3	bottle	Glass	5.80E+03	5.40E+01	107.407	1	70.000	4.677
RH9G	bottle	Glass	3.70E+03	2.30E+01	160.870	1	71.818	5.081
RH9QQ	bottle	Poly	1.90E+04	1.10E+02	172.727	1	73.636	5.152
RH9N	cell	Metal	5.00E+03	2.70E+01	185.185	1	75.455	5.221
RH9L	glassware	Glass	2.40E+03	1.20E+01	200.000	1	77.273	5.298
RH9P	Wire	Metal	4.00E+03	1.90E+01	210.526	1	79.091	5.350
RH9Q	tool	Metal	3.80E+03	1.70E+01	223.529	1	80.909	5.410
RH9SS	Lid	Poly	2.40E+03	1.00E+01	240.000	1	82.727	5.481
LN-25	bottle	Glass	8.80E+03	3.40E+01	258.824	1	84.545	5.556
RH9U	Lid	Poly	2.20E+03	7.00E+00	314.286	1	86.364	5.750
RH9KK	bottle	Glass	2.00E+03	6.20E+00	322.581	1	88.182	5.776
RH9M	cell	Metal	7.80E+03	2.30E+01	339.130	1	90.000	5.826
RH9S	tool	Metal	5.70E+03	1.50E+01	380.000	1	91.818	5.940
RH9R	cap	Metal	4.10E+03	8.40E+00	488.095	1	93.636	6.191
RH9V	Valve	Poly	1.60E+04	2.60E+01	615.385	1	95.455	6.422
LN-6	tool	Metal	4.10E+05	7.80E+01	5,256.410	1	97.273	8.567
LN-15	bottles	Glass	5.00E+05	5.50E+01	9,090.909	1	99.091	9.115

Cm246/Ag110m

Sample ID	Waste Component	Waste Group	Cm246 (Bq/total)	Ag110m (Bq/total)	Cm246/Ag110m X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9O	housing	Glass	5.25E+01	1.10E+03	0.048	1	0.909	-3.042
RH9F	Valve	Poly	4.00E+02	4.60E+02	0.870	1	2.727	-0.140
RH9LL	bottle	Glass	1.20E+02	1.20E+02	1.000	1	4.545	0.000
RH9T	Wipes	Wipes	1.60E+02	5.00E+01	3.200	1	6.364	1.163
LN-26	bottle	Glass	1.45E+04	3.30E+03	4.394	1	8.182	1.480
LN-40	hose	Poly	1.45E+04	3.10E+03	4.677	1	10.000	1.543
LN-1	bottle	Glass	1.10E+04	2.20E+03	5.000	1	11.818	1.609
RH9EE	Valve	Poly	6.20E+02	1.20E+02	5.167	1	13.636	1.642
LN-38	tool	Metal	8.40E+02	1.40E+02	6.000	1	15.455	1.792
RH9E	Valve	Poly	2.60E+02	3.90E+01	6.667	1	17.273	1.897
RH9V	Wipes	Wipes	1.80E+02	2.60E+01	6.923	1	19.091	1.935
LN-46	can	Metal	3.80E+02	4.80E+01	7.917	1	20.909	2.069
RH9H	Light Cord	Poly	5.15E+02	6.20E+01	8.306	1	22.727	2.117
LN-54	case	Metal	1.80E+03	1.50E+02	12.000	1	24.545	2.485
LN-11	bottle	Glass	1.10E+04	8.80E+02	12.500	1	26.364	2.526
RH9G	Valve	Poly	2.90E+02	2.30E+01	12.609	1	28.182	2.534
RH9I	MSM Boot	Poly	6.30E+02	4.70E+01	13.404	1	30.000	2.596
LN-44	cap	Metal	3.50E+03	2.60E+02	13.462	1	31.818	2.600
LN-7	tool	Metal	2.10E+03	1.50E+02	14.000	1	33.636	2.639
LN-GL	bottles	Glass	1.20E+06	7.70E+04	15.584	1	35.455	2.746
RH9A	Melt	Poly	1.10E+02	7.00E+00	15.714	1	37.273	2.755
RH9AA	Melt	Poly	9.10E+01	5.70E+00	15.965	1	39.091	2.770
RH9QQ	Wire	Metal	1.95E+03	1.10E+02	17.727	1	40.909	2.875
RH9U	Wipes	Wipes	1.55E+02	7.00E+00	22.143	1	42.727	3.098
RH9K	Lid	Poly	3.30E+02	1.40E+01	23.571	1	44.545	3.160
RH9J	Lid	Poly	5.20E+02	2.20E+01	23.636	1	46.364	3.163
RH9R	Lid	Metal	2.15E+02	8.40E+00	25.595	1	48.182	3.242
LN-41	column	Metal	4.80E+03	1.60E+02	30.000	1	50.000	3.401
RH9C	Melt	Poly	3.50E+02	1.10E+01	31.818	1	51.818	3.460
RH9D	bckt	Poly	4.85E+02	1.40E+01	34.643	1	53.636	3.545
LN-33	valve	Poly	1.40E+04	3.70E+02	37.838	1	55.455	3.633
LN-49	socket	Metal	1.20E+03	3.10E+01	38.710	1	57.273	3.656
LN-35	bottle	Poly	1.50E+04	3.50E+02	42.857	1	59.091	3.758
LN-ML	tool	Metal	7.30E+05	1.70E+04	42.941	1	60.909	3.760
RH9M	bottle	Glass	1.00E+03	2.30E+01	43.478	1	62.727	3.772
RH9L	bottle	Glass	6.00E+02	1.20E+01	50.000	1	64.545	3.912
RH9Q	Wire	Metal	8.75E+02	1.70E+01	51.471	1	66.364	3.941
RH9P	Tool	Metal	9.90E+02	1.90E+01	52.105	1	68.182	3.953
LN-15	tool	Metal	3.30E+03	5.50E+01	60.000	1	70.000	4.094
LN-19	bottle	Glass	9.05E+03	1.50E+02	60.333	1	71.818	4.100
RH9SS	Wipes	Wipes	6.10E+02	1.00E+01	61.000	1	73.636	4.111
RH9N	glassware	Glass	1.95E+03	2.70E+01	72.222	1	75.455	4.280
LN-25	bottle	Glass	2.70E+03	3.40E+01	79.412	1	77.273	4.375
LN-48	tool	Metal	3.90E+03	4.60E+01	84.783	1	79.091	4.440
RH9KK	Lid	Poly	5.75E+02	6.20E+00	92.742	1	80.909	4.530
RH9S	Wipes	Wipes	1.50E+03	1.50E+01	100.000	1	82.727	4.605
LN-4	bottle	Glass	1.30E+04	1.20E+02	108.333	1	84.545	4.685
LN-39	cell	Metal	3.90E+04	2.00E+02	195.000	1	86.364	5.273
LN-28	bottle	Glass	1.10E+04	5.20E+01	211.538	1	88.182	5.354
LN-6	bottle	Glass	2.30E+04	7.80E+01	294.872	1	90.000	5.687
LN-8	bottle	Glass	1.60E+04	5.10E+01	313.725	1	91.818	5.749
LN-9	bulb	Glass	2.05E+04	5.50E+01	372.727	1	93.636	5.921
LN-13	bottle	Glass	2.30E+04	4.60E+01	500.000	1	95.455	6.215
LN-3	bottle	Glass	2.85E+04	5.40E+01	527.778	1	97.273	6.269
LN-36	cell	Metal	2.90E+04	5.40E+01	537.037	1	99.091	6.286

C3. Activity ratios of alpha emitting radionuclides and Sb-125

Cm244/Sb125

Sample ID	Waste Component	Waste Group	Cm244 (Bq/total)	Sb125 (Bq/total)	Cm244/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottles	Glass	1.50E+04	2.30E+05	0.065	1	0.909	-2.730
LN-ML	tool	Metal	5.50E+04	1.10E+05	0.500	1	2.727	-0.693
LN-40	hose	Poly	1.50E+04	3.00E+03	5.000	1	4.545	1.609
LN-39	cell	Metal	8.30E+03	1.40E+03	5.929	1	6.364	1.780
LN-11	bottle	Glass	1.10E+04	1.40E+03	7.857	1	8.182	2.061
LN-36	cell	Metal	1.00E+04	1.20E+03	8.333	1	10.000	2.120
LN-41	column	Metal	5.40E+04	3.90E+03	13.846	1	11.818	2.628
LN-13	bottle	Glass	3.40E+03	2.00E+02	17.000	1	13.636	2.833
LN-26	bottle	Glass	4.60E+04	1.50E+03	30.667	1	15.455	3.423
LN-44	cap	Metal	2.40E+04	5.10E+02	47.059	1	17.273	3.851
LN-19	bottle	Glass	4.20E+04	8.60E+02	48.837	1	19.091	3.888
LN-6	bottle	Glass	9.30E+04	1.70E+03	54.706	1	20.909	4.002
LN-48	tool	Metal	4.90E+04	8.90E+02	55.056	1	22.727	4.008
LN-33	valve	Poly	1.90E+05	3.20E+03	59.375	1	24.545	4.084
LN-46	can	Metal	3.30E+04	5.30E+02	62.264	1	26.364	4.131
LN-54	case	Metal	5.80E+04	5.60E+02	103.571	1	28.182	4.640
LN-9	bulb	Glass	2.10E+04	2.00E+02	105.000	1	30.000	4.654
RH9P	Tool	Metal	8.20E+04	6.00E+02	136.667	1	31.818	4.918
RH9J	Lid	Poly	5.20E+04	2.90E+02	179.310	1	33.636	5.189
RH9M	bottle	Glass	1.50E+05	5.30E+02	283.019	1	35.455	5.646
RH9I	MSM Boot	Poly	9.40E+04	3.20E+02	293.750	1	37.273	5.683
LN-8	bottle	Glass	3.80E+05	1.10E+03	345.455	1	39.091	5.845
LN-7	tool	Metal	6.00E+04	1.50E+02	400.000	1	40.909	5.991
LN-49	socket	Metal	1.20E+05	2.70E+02	444.444	1	42.727	6.097
LN-35	bottle	Poly	1.40E+06	2.90E+03	482.759	1	44.545	6.180
LN-3	bottle	Glass	1.40E+06	2.50E+03	560.000	2	48.182	6.328
RH9G	Valve	Poly	2.80E+04	5.00E+01	560.000	0	48.182	6.328
RH9H	Light Cord	Poly	1.00E+05	1.50E+02	666.667	1	50.000	6.502
LN-38	tool	Metal	5.30E+05	6.60E+02	803.030	1	51.818	6.688
LN-1	bottle	Glass	1.40E+06	1.70E+03	823.529	1	53.636	6.714
RH9E	Valve	Poly	9.70E+04	9.90E+01	979.798	1	55.455	6.887
RH9N	glassware	Glass	9.00E+05	8.80E+02	1022.727	1	57.273	6.930
LN-15	tool	Metal	1.10E+06	1.00E+03	1100.000	1	59.091	7.003
LN-28	bottle	Glass	1.10E+06	9.90E+02	1111.111	1	60.909	7.013
LN-4	bottle	Glass	2.00E+05	1.70E+02	1176.471	1	62.727	7.070
RH9S	Wipes	Wipes	2.30E+06	1.90E+03	1210.526	1	64.545	7.099
RH9C	Melt	Poly	1.70E+05	1.40E+02	1214.286	1	66.364	7.102
RH9EE	Valve	Poly	5.90E+05	4.70E+02	1255.319	1	68.182	7.135
RH9LL	bottle	Glass	1.10E+06	8.60E+02	1279.070	1	70.000	7.154
RH9O	housing	Glass	6.00E+05	1.90E+02	3157.895	1	71.818	8.058
RH9KK	Lid	Poly	3.80E+05	1.20E+02	3166.667	1	73.636	8.060
RH9F	Valve	Poly	2.00E+05	5.60E+01	3571.429	1	75.455	8.181
RH9K	Lid	Poly	1.40E+06	3.00E+02	4666.667	1	77.273	8.448
RH9QQ	Wire	Metal	2.00E+06	3.50E+02	5714.286	1	79.091	8.651
RH9L	bottle	Glass	3.40E+05	4.00E+01	8500.000	1	80.909	9.048
RH9A	Melt	Poly	1.80E+05	2.10E+01	8571.429	1	82.727	9.056
RH9SS	Wipes	Wipes	2.80E+06	3.20E+02	8750.000	1	84.545	9.077
RH9Q	Wire	Metal	6.60E+05	5.00E+01	13200.000	1	86.364	9.488
RH9D	bckt	Poly	1.30E+06	9.70E+01	13402.062	1	88.182	9.503
RH9R	Lid	Metal	1.60E+06	9.40E+01	17021.277	1	90.000	9.742
RH9V	Wipes	Wipes	9.40E+06	2.20E+02	42727.273	1	91.818	10.663
RH9T	Wipes	Wipes	2.30E+06	3.00E+01	76666.667	1	93.636	11.247
LN-25	bottle	Glass	1.20E+08	5.80E+02	206896.552	1	95.455	12.240
RH9U	Wipes	Wipes	1.30E+07	2.40E+01	541666.667	1	97.273	13.202
RH9AA	Melt	Poly	6.90E+07	2.00E+01	3450000.000	1	99.091	15.054

Pu238/Sb125

Sample ID	Waste Component	Waste Group	Pu238 (Bq/total)	Sb125 (Bq/total)	Pu238/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9I	MSM Boot	Poly	3.50E+01	3.20E+02	0.109	1	0.909	-2.213
LN-40	hose	Poly	3.80E+02	3.00E+03	0.127	1	2.727	-2.066
RH9LL	bottle	Glass	1.20E+02	8.60E+02	0.140	1	4.545	-1.969
RH9M	bottle	Glass	1.00E+02	5.30E+02	0.189	1	6.364	-1.668
RH9H	Light Cord	Poly	2.90E+01	1.50E+02	0.193	1	8.182	-1.643
RH9O	housing	Glass	5.25E+01	1.90E+02	0.276	2	11.818	-1.286
LN-1	bottle	Glass	4.70E+02	1.70E+03	0.276	0	11.818	-1.286
RH9SS	Wipes	Wipes	1.10E+02	3.20E+02	0.344	1	13.636	-1.068
LN-41	column	Metal	2.00E+03	3.90E+03	0.513	1	15.455	-0.668
LN-3	bottle	Glass	1.40E+03	2.50E+03	0.560	1	17.273	-0.580
LN-8	bottle	Glass	7.90E+02	1.10E+03	0.718	1	19.091	-0.331
LN-26	bottle	Glass	1.10E+03	1.50E+03	0.733	1	20.909	-0.310
LN-25	bottle	Glass	4.40E+02	5.80E+02	0.759	1	22.727	-0.276
RH9S	Wipes	Wipes	1.50E+03	1.90E+03	0.789	1	24.545	-0.236
LN-11	bottle	Glass	1.30E+03	1.40E+03	0.929	1	26.364	-0.074
RH9J	Lid	Poly	2.70E+02	2.90E+02	0.931	1	28.182	-0.071
LN-6	bottle	Glass	1.70E+03	1.70E+03	1.000	1	30.000	0.000
LN-38	tool	Metal	6.90E+02	6.60E+02	1.045	1	31.818	0.044
LN-GL	bottles	Glass	2.70E+05	2.30E+05	1.174	1	33.636	0.160
LN-19	bottle	Glass	1.10E+03	8.60E+02	1.279	1	35.455	0.246
LN-28	bottle	Glass	1.40E+03	9.90E+02	1.414	1	37.273	0.347
LN-49	socket	Metal	4.00E+02	2.70E+02	1.481	1	39.091	0.393
RH9V	Wipes	Wipes	3.60E+02	2.20E+02	1.636	1	40.909	0.492
RH9P	Tool	Metal	9.90E+02	6.00E+02	1.650	1	42.727	0.501
LN-48	tool	Metal	1.60E+03	8.90E+02	1.798	1	44.545	0.587
LN-36	cell	Metal	2.30E+03	1.20E+03	1.917	1	46.364	0.651
LN-33	valve	Poly	6.40E+03	3.20E+03	2.000	1	48.182	0.693
LN-46	can	Metal	1.10E+03	5.30E+02	2.075	1	50.000	0.730
LN-39	cell	Metal	3.00E+03	1.40E+03	2.143	1	51.818	0.762
RH9N	glassware	Glass	1.95E+03	8.80E+02	2.216	1	53.636	0.796
RH9K	Lid	Poly	6.80E+02	3.00E+02	2.267	1	55.455	0.818
LN-54	case	Metal	1.40E+03	5.60E+02	2.500	1	57.273	0.916
RH9R	Lid	Metal	2.40E+02	9.40E+01	2.553	1	59.091	0.937
RH9C	Melt	Poly	4.20E+02	1.40E+02	3.000	1	60.909	1.099
RH9E	Valve	Poly	3.00E+02	9.90E+01	3.030	1	62.727	1.109
LN-9	bulb	Glass	6.60E+02	2.00E+02	3.300	1	64.545	1.194
LN-35	bottle	Poly	1.40E+04	2.90E+03	4.828	1	66.364	1.574
RH9D	bckt	Poly	4.85E+02	9.70E+01	5.000	1	68.182	1.609
LN-13	bottle	Glass	1.10E+03	2.00E+02	5.500	1	70.000	1.705
RH9QQ	Wire	Metal	1.95E+03	3.50E+02	5.571	1	71.818	1.718
LN-4	bottle	Glass	9.80E+02	1.70E+02	5.765	1	73.636	1.752
LN-44	cap	Metal	3.10E+03	5.10E+02	6.078	1	75.455	1.805
RH9A	Melt	Poly	1.30E+02	2.10E+01	6.190	1	77.273	1.823
LN-15	tool	Metal	6.30E+03	1.00E+03	6.300	1	79.091	1.841
RH9U	Wipes	Wipes	1.55E+02	2.40E+01	6.458	1	80.909	1.865
RH9KK	Lid	Poly	8.50E+02	1.20E+02	7.083	1	82.727	1.958
RH9AA	Melt	Poly	1.70E+02	2.00E+01	8.500	1	84.545	2.140
LN-ML	tool	Metal	1.10E+06	1.10E+05	10.000	1	86.364	2.303
RH9L	bottle	Glass	5.00E+02	4.00E+01	12.500	1	88.182	2.526
RH9T	Wipes	Wipes	3.90E+02	3.00E+01	13.000	1	90.000	2.565
RH9EE	Valve	Poly	6.20E+03	4.70E+02	13.191	1	91.818	2.580
RH9G	Valve	Poly	8.00E+02	5.00E+01	16.000	1	93.636	2.773
RH9Q	Wire	Metal	8.75E+02	5.00E+01	17.500	1	95.455	2.862
RH9F	Valve	Poly	1.00E+03	5.60E+01	17.857	1	97.273	2.882
LN-7	tool	Metal	3.40E+03	1.50E+02	22.667	1	99.091	3.121

Pu*/Sb125

Sample ID	Waste Component	Waste Group	Pu* (Bq/total)	Sb125 (Bq/total)	Pu*/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-ML	tool	Wipes	1.55E+02	1.10E+05	0.001	1	0.909	-6.565
LN-39	cell	Poly	5.80E+01	1.40E+03	0.041	1	2.727	-3.184
LN-3	bottle	Wipes	1.20E+02	2.50E+03	0.048	1	4.545	-3.037
LN-41	column	Metal	4.00E+02	3.90E+03	0.103	1	6.364	-2.277
LN-33	valve	Poly	4.85E+02	3.20E+03	0.152	1	8.182	-1.887
RH9S	Wipes	Wipes	2.90E+02	1.90E+03	0.153	2	11.818	-1.880
LN-40	hose	Glass	4.60E+02	3.00E+03	0.153	0	11.818	-1.875
LN-1	bottle	Poly	2.90E+02	1.70E+03	0.171	1	13.636	-1.769
LN-35	bottle	Poly	5.20E+02	2.90E+03	0.179	1	15.455	-1.719
LN-48	tool	Poly	2.50E+02	8.90E+02	0.281	1	17.273	-1.270
LN-46	can	Wipes	1.50E+02	5.30E+02	0.283	1	19.091	-1.262
RH9N	glassware	Poly	2.60E+02	8.80E+02	0.295	1	20.909	-1.219
LN-8	bottle	Wipes	3.50E+02	1.10E+03	0.318	1	22.727	-1.145
LN-26	bottle	Metal	4.80E+02	1.50E+03	0.320	1	24.545	-1.139
LN-6	bottle	Metal	5.70E+02	1.70E+03	0.335	1	26.364	-1.093
LN-11	bottle	Glass	5.10E+02	1.40E+03	0.364	1	28.182	-1.010
LN-9	bulb	Poly	1.10E+02	2.00E+02	0.550	1	30.000	-0.598
LN-13	bottle	Glass	1.20E+02	2.00E+02	0.600	1	31.818	-0.511
LN-28	bottle	Metal	6.80E+02	9.90E+02	0.687	1	33.636	-0.376
RH9EE	Valve	Metal	4.00E+02	4.70E+02	0.851	1	35.455	-0.161
LN-54	case	Poly	6.20E+02	5.60E+02	1.107	1	37.273	0.102
LN-GL	bottles	Metal	2.90E+05	2.30E+05	1.261	1	39.091	0.232
LN-38	tool	Metal	9.30E+02	6.60E+02	1.409	1	40.909	0.343
LN-49	socket	Glass	4.00E+02	2.70E+02	1.481	1	42.727	0.393
RH9I	MSM Boot	Poly	5.15E+02	3.20E+02	1.609	1	44.545	0.476
RH9H	Light Cord	Poly	2.60E+02	1.50E+02	1.733	1	46.364	0.550
LN-36	cell	Metal	2.10E+03	1.20E+03	1.750	1	48.182	0.560
RH9KK	Lid	Metal	2.15E+02	1.20E+02	1.792	1	50.000	0.583
RH9LL	bottle	Metal	1.80E+03	8.60E+02	2.093	1	51.818	0.739
RH9C	Melt	Glass	3.00E+02	1.40E+02	2.143	1	53.636	0.762
LN-44	cap	Metal	1.10E+03	5.10E+02	2.157	1	55.455	0.769
LN-19	bottle	Glass	2.00E+03	8.60E+02	2.326	1	57.273	0.844
RH9J	Lid	Glass	1.10E+03	2.90E+02	3.793	1	59.091	1.333
RH9A	Melt	Poly	9.10E+01	2.10E+01	4.333	1	60.909	1.466
RH9D	bckt	Poly	4.40E+02	9.70E+01	4.536	1	62.727	1.512
LN-25	bottle	Poly	3.60E+03	5.80E+02	6.207	1	64.545	1.826
RH9G	Valve	Poly	3.50E+02	5.00E+01	7.000	1	66.364	1.946
RH9P	Tool	Glass	4.70E+03	6.00E+02	7.833	1	68.182	2.058
RH9F	Valve	Poly	5.00E+02	5.60E+01	8.929	1	70.000	2.189
RH9M	bottle	Glass	4.90E+03	5.30E+02	9.245	1	71.818	2.224
RH9E	Valve	Metal	9.50E+02	9.90E+01	9.596	1	73.636	2.261
RH9SS	Wipes	Metal	3.80E+03	3.20E+02	11.875	1	75.455	2.474
RH9QQ	Wire	Glass	6.30E+03	3.50E+02	18.000	1	77.273	2.890
RH9K	Lid	Poly	5.50E+03	3.00E+02	18.333	1	79.091	2.909
RH9O	housing	Glass	4.00E+03	1.90E+02	21.053	1	80.909	3.047
LN-7	tool	Glass	4.00E+03	1.50E+02	26.667	1	82.727	3.283
RH9L	bottle	Metal	1.40E+03	4.00E+01	35.000	1	84.545	3.555
RH9U	Wipes	Metal	8.75E+02	2.40E+01	36.458	1	86.364	3.596
RH9V	Wipes	Glass	8.90E+03	2.20E+02	40.455	1	88.182	3.700
LN-4	bottle	Glass	6.90E+03	1.70E+02	40.588	1	90.000	3.703
RH9AA	Melt	Glass	1.10E+03	2.00E+01	55.000	1	91.818	4.007
RH9R	Lid	Glass	6.60E+03	9.40E+01	70.213	1	93.636	4.252
RH9Q	Wire	Metal	6.20E+03	5.00E+01	124.000	1	95.455	4.820
RH9T	Wipes	Glass	6.30E+03	3.00E+01	210.000	1	97.273	5.347
LN-15	tool	Glass	3.20E+05	1.00E+03	320.000	1	99.091	5.768

Pu242/Sb125

Sample ID	Waste Component	Waste Group	Pu242 (Bq/total)	Sb125 (Bq/total)	Pu242/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	8.70E+00	3.00E+03	0.003	1	0.909	-5.843
LN-3	bottle	Glass	1.50E+01	2.50E+03	0.006	1	2.727	-5.116
LN-39	cell	Metal	9.30E+00	1.40E+03	0.007	1	4.545	-5.014
LN-41	column	Metal	3.30E+01	3.90E+03	0.008	1	6.364	-4.772
LN-6	bottle	Glass	1.60E+01	1.70E+03	0.009	1	8.182	-4.666
LN-1	bottle	Glass	2.00E+01	1.70E+03	0.012	1	10.000	-4.443
LN-25	bottle	Glass	8.00E+00	5.80E+02	0.014	2	13.636	-4.284
LN-11	bottle	Glass	2.00E+01	1.40E+03	0.014	0	13.636	-4.248
LN-48	tool	Metal	1.30E+01	8.90E+02	0.015	1	15.455	-4.226
LN-33	valve	Poly	5.00E+01	3.20E+03	0.016	1	17.273	-4.159
LN-GL	bottles	Glass	4.20E+03	2.30E+05	0.018	1	19.091	-4.003
LN-36	cell	Metal	2.40E+01	1.20E+03	0.020	1	20.909	-3.912
LN-46	can	Metal	1.70E+01	5.30E+02	0.032	1	22.727	-3.440
LN-19	bottle	Glass	3.20E+01	8.60E+02	0.037	1	24.545	-3.291
LN-8	bottle	Glass	4.40E+01	1.10E+03	0.040	1	26.364	-3.219
LN-38	tool	Metal	2.80E+01	6.60E+02	0.042	1	28.182	-3.160
LN-26	bottle	Glass	6.50E+01	1.50E+03	0.043	1	30.000	-3.139
LN-28	bottle	Glass	4.90E+01	9.90E+02	0.049	1	31.818	-3.006
LN-54	case	Metal	3.40E+01	5.60E+02	0.061	1	33.636	-2.802
LN-15	tool	Metal	6.60E+01	1.00E+03	0.066	1	35.455	-2.718
LN-35	bottle	Poly	2.00E+02	2.90E+03	0.069	1	37.273	-2.674
LN-44	cap	Metal	4.60E+01	5.10E+02	0.090	1	39.091	-2.406
LN-13	bottle	Glass	2.00E+01	2.00E+02	0.100	1	40.909	-2.303
LN-4	bottle	Glass	2.00E+01	1.70E+02	0.118	2	44.545	-2.140
LN-ML	tool	Metal	1.30E+04	1.10E+05	0.118	0	44.545	-2.136
RH9LL	bottle	Glass	1.20E+02	8.60E+02	0.140	1	46.364	-1.969
LN-9	bulb	Glass	3.90E+01	2.00E+02	0.195	1	48.182	-1.635
RH9O	housing	Glass	5.25E+01	1.90E+02	0.276	1	50.000	-1.286
LN-49	socket	Metal	8.20E+01	2.70E+02	0.304	1	51.818	-1.192
LN-7	tool	Metal	4.80E+01	1.50E+02	0.320	1	53.636	-1.139
RH9S	Wipes	Wipes	1.50E+03	1.90E+03	0.789	1	55.455	-0.236
RH9P	Tool	Metal	9.90E+02	6.00E+02	1.650	1	57.273	0.501
RH9J	Lid	Poly	5.20E+02	2.90E+02	1.793	1	59.091	0.584
RH9M	bottle	Glass	1.00E+03	5.30E+02	1.887	1	60.909	0.635
RH9SS	Wipes	Wipes	6.10E+02	3.20E+02	1.906	1	62.727	0.645
RH9I	MSM Boot	Poly	6.35E+02	3.20E+02	1.984	1	64.545	0.685
RH9N	glassware	Glass	1.95E+03	8.80E+02	2.216	1	66.364	0.796
RH9R	Lid	Metal	2.15E+02	9.40E+01	2.287	1	68.182	0.827
RH9C	Melt	Poly	3.50E+02	1.40E+02	2.500	1	70.000	0.916
RH9E	Valve	Poly	2.60E+02	9.90E+01	2.626	1	71.818	0.966
RH9V	Wipes	Wipes	5.85E+02	2.20E+02	2.659	1	73.636	0.978
RH9H	Light Cord	Poly	5.15E+02	1.50E+02	3.433	1	75.455	1.234
RH9K	Lid	Poly	1.10E+03	3.00E+02	3.667	1	77.273	1.299
RH9AA	Melt	Poly	9.10E+01	2.00E+01	4.550	1	79.091	1.515
RH9KK	Lid	Poly	5.75E+02	1.20E+02	4.792	1	80.909	1.567
RH9D	bckt	Poly	4.85E+02	9.70E+01	5.000	1	82.727	1.609
RH9A	Melt	Poly	1.10E+02	2.10E+01	5.238	1	84.545	1.656
RH9T	Wipes	Wipes	1.65E+02	3.00E+01	5.500	1	86.364	1.705
RH9QQ	Wire	Metal	1.95E+03	3.50E+02	5.571	1	88.182	1.718
RH9G	Valve	Poly	2.90E+02	5.00E+01	5.800	1	90.000	1.758
RH9U	Wipes	Wipes	1.55E+02	2.40E+01	6.458	1	91.818	1.865
RH9EE	Valve	Poly	6.20E+03	4.70E+02	13.191	1	93.636	2.580
RH9L	bottle	Glass	6.00E+02	4.00E+01	15.000	1	95.455	2.708
RH9Q	Wire	Metal	8.75E+02	5.00E+01	17.500	1	97.273	2.862
RH9F	Valve	Poly	1.00E+03	5.60E+01	17.857	1	99.091	2.882

Am241/Sb125

Sample ID	Waste Component	Waste Group	Am241 (Bq/total)	Sb125 (Bq/total)	Am241/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9O	housing	Glass	5.40E+01	1.90E+02	0.284	1	0.909	-1.258
RH9LL	bottle	Glass	8.50E+02	8.60E+02	0.988	1	2.727	-0.012
LN-3	bottle	Glass	2.50E+03	2.50E+03	1.000	1	4.545	0.000
RH9S	Wipes	Wipes	2.10E+03	1.90E+03	1.105	1	6.364	0.100
LN-26	bottle	Glass	1.70E+03	1.50E+03	1.133	1	8.182	0.125
LN-41	column	Metal	7.20E+03	3.90E+03	1.846	1	10.000	0.613
RH9SS	Wipes	Wipes	6.20E+02	3.20E+02	1.938	1	11.818	0.661
RH9KK	Lid	Poly	2.50E+02	1.20E+02	2.083	1	13.636	0.734
LN-19	bottle	Glass	1.90E+03	8.60E+02	2.209	1	15.455	0.793
LN-28	bottle	Glass	2.20E+03	9.90E+02	2.222	1	17.273	0.799
RH9R	Lid	Metal	2.20E+02	9.40E+01	2.340	1	19.091	0.850
RH9J	Lid	Poly	7.20E+02	2.90E+02	2.483	1	20.909	0.909
LN-38	tool	Metal	1.70E+03	6.60E+02	2.576	1	22.727	0.946
RH9M	bottle	Glass	1.40E+03	5.30E+02	2.642	1	24.545	0.971
LN-GL	bottles	Glass	6.20E+05	2.30E+05	2.696	1	26.364	0.992
RH9I	MSM Boot	Poly	9.10E+02	3.20E+02	2.844	1	28.182	1.045
RH9T	Wipes	Wipes	8.70E+01	3.00E+01	2.900	1	30.000	1.065
LN-8	bottle	Glass	3.20E+03	1.10E+03	2.909	1	31.818	1.068
RH9G	Valve	Poly	1.60E+02	5.00E+01	3.200	1	33.636	1.163
LN-49	socket	Metal	8.90E+02	2.70E+02	3.296	1	35.455	1.193
RH9V	Wipes	Wipes	7.60E+02	2.20E+02	3.455	1	37.273	1.240
RH9E	Valve	Poly	3.50E+02	9.90E+01	3.535	1	39.091	1.263
LN-40	hose	Poly	1.10E+04	3.00E+03	3.667	2	42.727	1.299
RH9P	Tool	Metal	2.20E+03	6.00E+02	3.667	0	42.727	1.299
LN-46	can	Metal	2.00E+03	5.30E+02	3.774	1	44.545	1.328
LN-48	tool	Metal	3.70E+03	8.90E+02	4.157	1	46.364	1.425
LN-6	bottle	Glass	7.10E+03	1.70E+03	4.176	1	48.182	1.429
LN-1	bottle	Glass	7.30E+03	1.70E+03	4.294	1	50.000	1.457
LN-44	cap	Metal	2.20E+03	5.10E+02	4.314	1	51.818	1.462
RH9K	Lid	Poly	1.30E+03	3.00E+02	4.333	1	53.636	1.466
LN-11	bottle	Glass	6.20E+03	1.40E+03	4.429	1	55.455	1.488
LN-33	valve	Poly	1.50E+04	3.20E+03	4.688	1	57.273	1.545
RH9C	Melt	Poly	7.40E+02	1.40E+02	5.286	1	59.091	1.665
LN-15	tool	Metal	5.90E+03	1.00E+03	5.900	1	60.909	1.775
RH9EE	Valve	Poly	2.80E+03	4.70E+02	5.957	1	62.727	1.785
RH9H	Light Cord	Poly	9.40E+02	1.50E+02	6.267	1	64.545	1.835
LN-9	bulb	Glass	1.50E+03	2.00E+02	7.500	1	66.364	2.015
RH9F	Valve	Poly	4.60E+02	5.60E+01	8.214	1	68.182	2.106
LN-25	bottle	Glass	4.90E+03	5.80E+02	8.448	1	70.000	2.134
LN-ML	tool	Metal	9.30E+05	1.10E+05	8.455	1	71.818	2.135
RH9AA	Melt	Poly	1.70E+02	2.00E+01	8.500	1	73.636	2.140
LN-54	case	Metal	5.20E+03	5.60E+02	9.286	1	75.455	2.228
RH9D	bckt	Poly	1.00E+03	9.70E+01	10.309	1	77.273	2.333
RH9A	Melt	Poly	2.20E+02	2.10E+01	10.476	1	79.091	2.349
RH9N	glassware	Glass	1.10E+04	8.80E+02	12.500	1	80.909	2.526
LN-4	bottle	Glass	2.20E+03	1.70E+02	12.941	1	82.727	2.560
RH9U	Wipes	Wipes	3.20E+02	2.40E+01	13.333	1	84.545	2.590
LN-13	bottle	Glass	2.80E+03	2.00E+02	14.000	1	86.364	2.639
RH9QQ	Wire	Metal	5.60E+03	3.50E+02	16.000	1	88.182	2.773
LN-7	tool	Metal	2.50E+03	1.50E+02	16.667	1	90.000	2.813
LN-35	bottle	Poly	5.80E+04	2.90E+03	20.000	1	91.818	2.996
RH9L	bottle	Glass	8.20E+02	4.00E+01	20.500	1	93.636	3.020
RH9Q	Wire	Metal	3.00E+03	5.00E+01	60.000	1	95.455	4.094
LN-36	cell	Metal	8.30E+04	1.20E+03	69.167	1	97.273	4.237
LN-39	cell	Metal	1.10E+05	1.40E+03	78.571	1	99.091	4.364

Am243/Sb125

Sample ID	Waste Component	Waste Group	Am243 (Bq/total)	Sb125 (Bq/total)	Am243/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9O	housing	Glass	4.00E+00	1.90E+02	0.021	1	0.909	-3.861
RH9LL	bottle	Glass	4.20E+01	8.60E+02	0.049	1	2.727	-3.019
LN-41	column	Metal	2.10E+02	3.90E+03	0.054	1	4.545	-2.922
RH9KK	Lid	Poly	1.10E+01	1.20E+02	0.092	1	6.364	-2.390
RH9J	Lid	Poly	2.90E+01	2.90E+02	0.100	1	8.182	-2.303
RH9R	Lid	Metal	1.00E+01	9.40E+01	0.106	1	10.000	-2.241
RH9SS	Wipes	Wipes	3.60E+01	3.20E+02	0.113	1	11.818	-2.185
RH9N	glassware	Glass	1.00E+02	8.80E+02	0.114	1	13.636	-2.175
LN-35	bottle	Poly	3.70E+02	2.90E+03	0.128	1	15.455	-2.059
RH9I	MSM Boot	Poly	4.20E+01	3.20E+02	0.131	1	17.273	-2.031
RH9C	Melt	Poly	2.10E+01	1.40E+02	0.150	1	19.091	-1.897
LN-26	bottle	Glass	2.40E+02	1.50E+03	0.160	2	22.727	-1.833
RH9P	Tool	Metal	9.60E+01	6.00E+02	0.160	0	22.727	-1.833
LN-19	bottle	Glass	1.40E+02	8.60E+02	0.163	1	24.545	-1.815
RH9M	bottle	Glass	8.90E+01	5.30E+02	0.168	2	28.182	-1.784
RH9S	Wipes	Wipes	3.20E+02	1.90E+03	0.168	0	28.182	-1.781
LN-48	tool	Metal	1.50E+02	8.90E+02	0.169	1	30.000	-1.781
RH9G	Valve	Poly	8.90E+00	5.00E+01	0.178	1	31.818	-1.726
LN-46	can	Metal	1.10E+02	5.30E+02	0.208	1	33.636	-1.572
LN-3	bottle	Glass	5.70E+02	2.50E+03	0.228	1	35.455	-1.478
RH9A	Melt	Poly	5.10E+00	2.10E+01	0.243	1	37.273	-1.415
RH9T	Wipes	Wipes	7.50E+00	3.00E+01	0.250	1	39.091	-1.386
LN-38	tool	Metal	1.70E+02	6.60E+02	0.258	1	40.909	-1.356
LN-1	bottle	Glass	4.50E+02	1.70E+03	0.265	1	42.727	-1.329
RH9K	Lid	Poly	8.10E+01	3.00E+02	0.270	1	44.545	-1.309
RH9D	bckt	Poly	2.80E+01	9.70E+01	0.289	1	46.364	-1.243
LN-15	tool	Metal	2.90E+02	1.00E+03	0.290	1	48.182	-1.238
LN-11	bottle	Glass	4.10E+02	1.40E+03	0.293	2	51.818	-1.228
LN-28	bottle	Glass	2.90E+02	9.90E+02	0.293	0	51.818	-1.228
RH9H	Light Cord	Poly	4.60E+01	1.50E+02	0.307	1	53.636	-1.182
LN-GL	bottles	Glass	7.10E+04	2.30E+05	0.309	1	55.455	-1.175
RH9V	Wipes	Wipes	6.90E+01	2.20E+02	0.314	1	57.273	-1.160
RH9E	Valve	Poly	3.20E+01	9.90E+01	0.323	1	59.091	-1.129
LN-49	socket	Metal	8.80E+01	2.70E+02	0.326	1	60.909	-1.121
RH9U	Wipes	Wipes	8.00E+00	2.40E+01	0.333	1	62.727	-1.099
LN-8	bottle	Glass	3.70E+02	1.10E+03	0.336	1	64.545	-1.090
RH9QQ	Wire	Metal	1.20E+02	3.50E+02	0.343	1	66.364	-1.070
LN-44	cap	Metal	1.90E+02	5.10E+02	0.373	1	68.182	-0.987
LN-25	bottle	Glass	2.20E+02	5.80E+02	0.379	1	70.000	-0.969
LN-6	bottle	Glass	6.80E+02	1.70E+03	0.400	1	71.818	-0.916
LN-33	valve	Poly	1.30E+03	3.20E+03	0.406	1	73.636	-0.901
RH9F	Valve	Poly	2.40E+01	5.60E+01	0.429	1	75.455	-0.847
LN-ML	tool	Metal	4.90E+04	1.10E+05	0.445	1	77.273	-0.809
RH9EE	Valve	Poly	2.10E+02	4.70E+02	0.447	1	79.091	-0.806
LN-7	tool	Metal	8.00E+01	1.50E+02	0.533	1	80.909	-0.629
RH9AA	Melt	Poly	1.10E+01	2.00E+01	0.550	1	82.727	-0.598
LN-54	case	Metal	3.20E+02	5.60E+02	0.571	1	84.545	-0.560
LN-36	cell	Metal	1.00E+03	1.20E+03	0.833	1	86.364	-0.182
RH9L	bottle	Glass	3.40E+01	4.00E+01	0.850	1	88.182	-0.163
LN-39	cell	Metal	1.20E+03	1.40E+03	0.857	1	90.000	-0.154
RH9Q	Wire	Metal	4.30E+01	5.00E+01	0.860	1	91.818	-0.151
LN-13	bottle	Glass	3.00E+02	2.00E+02	1.500	1	93.636	0.405
LN-9	bulb	Glass	3.10E+02	2.00E+02	1.550	1	95.455	0.438
LN-40	hose	Poly	5.80E+03	3.00E+03	1.933	1	97.273	0.659
LN-4	bottle	Glass	4.10E+02	1.70E+02	2.412	1	99.091	0.880

Cf252/Sb125

Sample ID	Waste Component	Waste Group	Cf252 (Bq/total)	Sb125 (Bq/total)	Cf252/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9S	Wipes	Wipes	3.90E+02	1.90E+03	0.205	1	0.909	-1.583
RH9LL	bottle	Glass	1.80E+02	8.60E+02	0.209	1	2.727	-1.564
LN-3	bottle	Glass	2.60E+03	2.50E+03	1.040	1	4.545	0.039
LN-41	column	Metal	6.00E+03	3.90E+03	1.538	1	6.364	0.431
LN-6	bottle	Glass	3.20E+03	1.70E+03	1.882	1	8.182	0.633
LN-25	bottle	Glass	1.10E+03	5.80E+02	1.897	1	10.000	0.640
RH9P	Tool	Metal	1.20E+03	6.00E+02	2.000	1	11.818	0.693
LN-28	bottle	Glass	2.10E+03	9.90E+02	2.121	1	13.636	0.752
LN-44	cap	Metal	1.20E+03	5.10E+02	2.353	1	15.455	0.856
LN-19	bottle	Glass	2.10E+03	8.60E+02	2.442	1	17.273	0.893
LN-8	bottle	Glass	2.80E+03	1.10E+03	2.545	1	19.091	0.934
LN-48	tool	Metal	2.50E+03	8.90E+02	2.809	1	20.909	1.033
LN-38	tool	Metal	1.90E+03	6.60E+02	2.879	1	22.727	1.057
LN-49	socket	Metal	7.80E+02	2.70E+02	2.889	1	24.545	1.061
RH9I	MSM Boot	Poly	9.40E+02	3.20E+02	2.938	1	26.364	1.078
RH9G	Valve	Poly	1.50E+02	5.00E+01	3.000	1	28.182	1.099
RH9N	glassware	Glass	2.90E+03	8.80E+02	3.295	1	30.000	1.193
LN-46	can	Metal	1.80E+03	5.30E+02	3.396	1	31.818	1.223
LN-39	cell	Metal	5.20E+03	1.40E+03	3.714	1	33.636	1.312
LN-36	cell	Metal	4.50E+03	1.20E+03	3.750	1	35.455	1.322
RH9SS	Wipes	Wipes	1.20E+03	3.20E+02	3.750	1	37.273	1.322
LN-26	bottle	Glass	5.80E+03	1.50E+03	3.867	1	39.091	1.352
LN-11	bottle	Glass	5.50E+03	1.40E+03	3.929	1	40.909	1.368
LN-33	valve	Poly	1.30E+04	3.20E+03	4.063	1	42.727	1.402
RH9R	Lid	Metal	3.90E+02	9.40E+01	4.149	1	44.545	1.423
LN-54	case	Metal	2.50E+03	5.60E+02	4.464	1	46.364	1.496
RH9H	Light Cord	Poly	7.00E+02	1.50E+02	4.667	1	48.182	1.540
RH9C	Melt	Poly	6.60E+02	1.40E+02	4.714	1	50.000	1.551
LN-GL	bottles	Glass	1.30E+06	2.30E+05	5.652	1	51.818	1.732
LN-40	hose	Poly	1.80E+04	3.00E+03	6.000	1	53.636	1.792
RH9M	bottle	Glass	3.20E+03	5.30E+02	6.038	1	55.455	1.798
RH9EE	Valve	Poly	3.10E+03	4.70E+02	6.596	1	57.273	1.886
RH9T	Wipes	Wipes	2.00E+02	3.00E+01	6.667	1	59.091	1.897
LN-35	bottle	Poly	2.10E+04	2.90E+03	7.241	1	60.909	1.980
RH9E	Valve	Poly	7.20E+02	9.90E+01	7.273	1	62.727	1.984
RH9O	housing	Glass	1.40E+03	1.90E+02	7.368	1	64.545	1.997
LN-9	bulb	Glass	1.60E+03	2.00E+02	8.000	1	66.364	2.079
RH9D	bckt	Poly	8.80E+02	9.70E+01	9.072	1	68.182	2.205
LN-1	bottle	Glass	1.60E+04	1.70E+03	9.412	1	70.000	2.242
RH9V	Wipes	Wipes	2.10E+03	2.20E+02	9.545	1	71.818	2.256
RH9QQ	Wire	Metal	3.40E+03	3.50E+02	9.714	1	73.636	2.274
LN-15	tool	Metal	1.00E+04	1.00E+03	10.000	1	75.455	2.303
RH9K	Lid	Poly	3.10E+03	3.00E+02	10.333	1	77.273	2.335
RH9AA	Melt	Poly	2.30E+02	2.00E+01	11.500	1	79.091	2.442
LN-13	bottle	Glass	2.50E+03	2.00E+02	12.500	1	80.909	2.526
RH9A	Melt	Poly	2.80E+02	2.10E+01	13.333	1	82.727	2.590
RH9U	Wipes	Wipes	3.20E+02	2.40E+01	13.333	1	84.545	2.590
RH9F	Valve	Poly	8.10E+02	5.60E+01	14.464	1	86.364	2.672
LN-4	bottle	Glass	2.50E+03	1.70E+02	14.706	1	88.182	2.688
RH9Q	Wire	Metal	8.40E+02	5.00E+01	16.800	1	90.000	2.821
LN-ML	tool	Metal	2.00E+06	1.10E+05	18.182	1	91.818	2.900
RH9KK	Lid	Poly	2.70E+03	1.20E+02	22.500	1	93.636	3.114
RH9J	Lid	Poly	7.10E+03	2.90E+02	24.483	1	95.455	3.198
LN-7	tool	Metal	4.80E+03	1.50E+02	32.000	1	97.273	3.466
RH9L	bottle	Glass	1.90E+03	4.00E+01	47.500	1	99.091	3.861

Cm242/Sb125

Sample ID	Waste Component	Waste Group	Cm242 (Bq/total)	Sb125 (Bq/total)	Cm242/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-ML	Wipes	Wipes	7.30E+02	1.10E+05	0.007	1	0.909	-5.015
LN-GL	bottle	Glass	3.10E+03	2.30E+05	0.013	1	2.727	-4.307
LN-41	Wipes	Wipes	2.10E+02	3.90E+03	0.054	1	4.545	-2.922
LN-11	bottle	Glass	1.20E+02	1.40E+03	0.086	1	6.364	-2.457
LN-35	bottle	Glass	6.10E+02	2.90E+03	0.210	1	8.182	-1.559
LN-13	housing	Glass	5.30E+01	2.00E+02	0.265	1	10.000	-1.328
LN-28	socket	Metal	3.00E+02	9.90E+02	0.303	1	11.818	-1.194
LN-46	Valve	Poly	1.70E+02	5.30E+02	0.321	1	13.636	-1.137
LN-19	can	Metal	3.20E+02	8.60E+02	0.372	1	15.455	-0.989
RH9EE	Melt	Poly	1.90E+02	4.70E+02	0.404	1	17.273	-0.906
LN-49	Valve	Poly	1.10E+02	2.70E+02	0.407	1	19.091	-0.898
LN-40	tool	Metal	1.50E+03	3.00E+03	0.500	1	20.909	-0.693
LN-54	Light Cord	Poly	4.30E+02	5.60E+02	0.768	1	22.727	-0.264
LN-39	tool	Metal	1.40E+03	1.40E+03	1.000	1	24.545	0.000
LN-26	column	Metal	1.70E+03	1.50E+03	1.133	2	28.182	0.125
LN-7	Melt	Poly	1.70E+02	1.50E+02	1.133	0	28.182	0.125
RH9J	Lid	Metal	3.40E+02	2.90E+02	1.172	1	30.000	0.159
LN-38	bckt	Poly	8.00E+02	6.60E+02	1.212	1	31.818	0.192
LN-8	Lid	Poly	2.20E+03	1.10E+03	2.000	1	33.636	0.693
LN-36	bottle	Glass	2.70E+03	1.20E+03	2.250	1	35.455	0.811
LN-3	bottle	Glass	5.80E+03	2.50E+03	2.320	1	37.273	0.842
LN-48	case	Metal	2.30E+03	8.90E+02	2.584	1	39.091	0.949
RH9K	Tool	Metal	8.00E+02	3.00E+02	2.667	1	40.909	0.981
LN-33	valve	Poly	9.40E+03	3.20E+03	2.938	1	42.727	1.078
LN-9	Valve	Poly	5.90E+02	2.00E+02	2.950	1	44.545	1.082
RH9S	tool	Metal	5.70E+03	1.90E+03	3.000	1	46.364	1.099
RH9E	Melt	Poly	5.30E+02	9.90E+01	5.354	1	48.182	1.678
RH9C	MSM Boot	Poly	7.60E+02	1.40E+02	5.429	1	50.000	1.692
RH9N	cell	Metal	5.00E+03	8.80E+02	5.682	1	51.818	1.737
RH9I	bottle	Glass	2.10E+03	3.20E+02	6.563	1	53.636	1.881
RH9P	Wire	Metal	4.00E+03	6.00E+02	6.667	1	55.455	1.897
RH9O	bottle	Glass	1.30E+03	1.90E+02	6.842	1	57.273	1.923
LN-4	bottle	Glass	1.20E+03	1.70E+02	7.059	1	59.091	1.954
RH9A	Wipes	Wipes	1.50E+02	2.10E+01	7.143	1	60.909	1.966
RH9LL	bulb	Glass	6.40E+03	8.60E+02	7.442	1	62.727	2.007
RH9SS	Lid	Poly	2.40E+03	3.20E+02	7.500	1	64.545	2.015
LN-1	hose	Poly	1.30E+04	1.70E+03	7.647	1	66.364	2.034
RH9D	Wipes	Wipes	9.50E+02	9.70E+01	9.794	1	68.182	2.282
RH9AA	Wipes	Wipes	2.90E+02	2.00E+01	14.500	1	70.000	2.674
RH9M	cell	Metal	7.80E+03	5.30E+02	14.717	1	71.818	2.689
LN-25	bottle	Glass	8.80E+03	5.80E+02	15.172	1	73.636	2.719
RH9KK	bottle	Glass	2.00E+03	1.20E+02	16.667	1	75.455	2.813
RH9H	bottle	Glass	3.60E+03	1.50E+02	24.000	1	77.273	3.178
LN-44	bottle	Glass	1.60E+04	5.10E+02	31.373	1	79.091	3.446
RH9F	bottle	Glass	2.30E+03	5.60E+01	41.071	1	80.909	3.715
RH9R	cap	Metal	4.10E+03	9.40E+01	43.617	1	82.727	3.775
RH9T	Wire	Metal	1.60E+03	3.00E+01	53.333	1	84.545	3.977
RH9QQ	bottle	Poly	1.90E+04	3.50E+02	54.286	1	86.364	3.994
RH9L	glassware	Glass	2.40E+03	4.00E+01	60.000	1	88.182	4.094
RH9V	Valve	Poly	1.60E+04	2.20E+02	72.727	1	90.000	4.287
RH9G	bottle	Glass	3.70E+03	5.00E+01	74.000	1	91.818	4.304
RH9Q	tool	Metal	3.80E+03	5.00E+01	76.000	1	93.636	4.331
RH9U	Lid	Poly	2.20E+03	2.40E+01	91.667	1	95.455	4.518
LN-6	tool	Metal	4.10E+05	1.70E+03	241.176	1	97.273	5.486
LN-15	bottles	Glass	5.00E+05	1.00E+03	500.000	1	99.091	6.215

Cm246/Sb125

Sample ID	Waste Component	Waste Group	Cm246 (Bq/total)	Sb125 (Bq/total)	Cm246/Sb125 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9LL	bottle	Glass	1.20E+02	8.60E+02	0.140	1	0.909	-1.969
RH9O	housing	Glass	5.25E+01	1.90E+02	0.276	1	2.727	-1.286
LN-46	can	Metal	3.80E+02	5.30E+02	0.717	1	4.545	-0.333
RH9S	Wipes	Wipes	1.50E+03	1.90E+03	0.789	1	6.364	-0.236
RH9V	Wipes	Wipes	1.80E+02	2.20E+02	0.818	1	8.182	-0.201
RH9K	Lid	Poly	3.30E+02	3.00E+02	1.100	1	10.000	0.095
LN-41	column	Metal	4.80E+03	3.90E+03	1.231	1	11.818	0.208
LN-38	tool	Metal	8.40E+02	6.60E+02	1.273	1	13.636	0.241
RH9EE	Valve	Poly	6.20E+02	4.70E+02	1.319	1	15.455	0.277
RH9P	Tool	Metal	9.90E+02	6.00E+02	1.650	1	17.273	0.501
RH9J	Lid	Poly	5.20E+02	2.90E+02	1.793	1	19.091	0.584
RH9M	bottle	Glass	1.00E+03	5.30E+02	1.887	1	20.909	0.635
RH9SS	Wipes	Wipes	6.10E+02	3.20E+02	1.906	1	22.727	0.645
RH9I	MSM Boot	Poly	6.30E+02	3.20E+02	1.969	1	24.545	0.677
RH9N	glassware	Glass	1.95E+03	8.80E+02	2.216	1	26.364	0.796
RH9R	Lid	Metal	2.15E+02	9.40E+01	2.287	1	28.182	0.827
RH9C	Melt	Poly	3.50E+02	1.40E+02	2.500	1	30.000	0.916
RH9E	Valve	Poly	2.60E+02	9.90E+01	2.626	1	31.818	0.966
LN-54	case	Metal	1.80E+03	5.60E+02	3.214	1	33.636	1.168
LN-15	tool	Metal	3.30E+03	1.00E+03	3.300	1	35.455	1.194
RH9H	Light Cord	Poly	5.15E+02	1.50E+02	3.433	1	37.273	1.234
LN-33	valve	Poly	1.40E+04	3.20E+03	4.375	1	39.091	1.476
LN-48	tool	Metal	3.90E+03	8.90E+02	4.382	1	40.909	1.478
LN-49	socket	Metal	1.20E+03	2.70E+02	4.444	1	42.727	1.492
RH9AA	Melt	Poly	9.10E+01	2.00E+01	4.550	1	44.545	1.515
LN-25	bottle	Glass	2.70E+03	5.80E+02	4.655	1	46.364	1.538
RH9KK	Lid	Poly	5.75E+02	1.20E+02	4.792	1	48.182	1.567
LN-40	hose	Poly	1.45E+04	3.00E+03	4.833	1	50.000	1.576
RH9D	bckt	Poly	4.85E+02	9.70E+01	5.000	1	51.818	1.609
LN-35	bottle	Poly	1.50E+04	2.90E+03	5.172	1	53.636	1.643
LN-GL	bottles	Glass	1.20E+06	2.30E+05	5.217	1	55.455	1.652
RH9A	Melt	Poly	1.10E+02	2.10E+01	5.238	1	57.273	1.656
RH9T	Wipes	Wipes	1.60E+02	3.00E+01	5.333	1	59.091	1.674
RH9QQ	Wire	Metal	1.95E+03	3.50E+02	5.571	1	60.909	1.718
RH9G	Valve	Poly	2.90E+02	5.00E+01	5.800	1	62.727	1.758
RH9U	Wipes	Wipes	1.55E+02	2.40E+01	6.458	1	64.545	1.865
LN-1	bottle	Glass	1.10E+04	1.70E+03	6.471	1	66.364	1.867
LN-ML	tool	Metal	7.30E+05	1.10E+05	6.636	1	68.182	1.893
LN-44	cap	Metal	3.50E+03	5.10E+02	6.863	1	70.000	1.926
RH9F	Valve	Poly	4.00E+02	5.60E+01	7.143	1	71.818	1.966
LN-11	bottle	Glass	1.10E+04	1.40E+03	7.857	1	73.636	2.061
LN-26	bottle	Glass	1.45E+04	1.50E+03	9.667	1	75.455	2.269
LN-19	bottle	Glass	9.05E+03	8.60E+02	10.523	1	77.273	2.354
LN-28	bottle	Glass	1.10E+04	9.90E+02	11.111	1	79.091	2.408
LN-3	bottle	Glass	2.85E+04	2.50E+03	11.400	1	80.909	2.434
LN-6	bottle	Glass	2.30E+04	1.70E+03	13.529	1	82.727	2.605
LN-7	tool	Metal	2.10E+03	1.50E+02	14.000	1	84.545	2.639
LN-8	bottle	Glass	1.60E+04	1.10E+03	14.545	1	86.364	2.677
RH9L	bottle	Glass	6.00E+02	4.00E+01	15.000	1	88.182	2.708
RH9Q	Wire	Metal	8.75E+02	5.00E+01	17.500	1	90.000	2.862
LN-36	cell	Metal	2.90E+04	1.20E+03	24.167	1	91.818	3.185
LN-39	cell	Metal	3.90E+04	1.40E+03	27.857	1	93.636	3.327
LN-4	bottle	Glass	1.30E+04	1.70E+02	76.471	1	95.455	4.337
LN-9	bulb	Glass	2.05E+04	2.00E+02	102.500	1	97.273	4.630
LN-13	bottle	Glass	2.30E+04	2.00E+02	115.000	1	99.091	4.745

C4. Activity ratios of alpha emitting radionuclides and Cs-134

Cm244/Cs134

Sample ID	Waste Component	Waste Group	Cm244 (Bq/total)	Cs134 (Bq/total)	Cm244/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottles	Glass	1.50E+04	5.00E+05	0.030	1	0.909	-3.507
LN-40	hose	Poly	1.50E+04	1.20E+04	1.250	1	2.727	0.223
LN-11	bottle	Glass	1.10E+04	2.90E+03	3.793	1	4.545	1.333
LN-ML	tool	Metal	5.50E+04	1.40E+04	3.929	1	6.364	1.368
LN-13	bottle	Glass	3.40E+03	5.40E+02	6.296	1	8.182	1.840
LN-36	cell	Metal	1.00E+04	4.10E+02	24.390	1	10.000	3.194
LN-39	cell	Metal	8.30E+03	3.00E+02	27.667	1	11.818	3.320
LN-6	bottle	Glass	9.30E+04	2.90E+03	32.069	1	13.636	3.468
LN-9	bulb	Glass	2.10E+04	3.10E+02	67.742	1	15.455	4.216
LN-26	bottle	Glass	4.60E+04	5.50E+02	83.636	1	17.273	4.426
LN-44	cap	Metal	2.40E+04	2.60E+02	92.308	1	19.091	4.525
LN-41	column	Metal	5.40E+04	4.90E+02	110.204	1	20.909	4.702
LN-19	bottle	Glass	4.20E+04	3.30E+02	127.273	1	22.727	4.846
LN-46	can	Metal	3.30E+04	2.50E+02	132.000	1	24.545	4.883
LN-48	tool	Metal	4.90E+04	3.50E+02	140.000	1	26.364	4.942
RH9J	Lid	Poly	5.20E+04	2.00E+02	260.000	1	28.182	5.561
LN-54	case	Metal	5.80E+04	2.20E+02	263.636	1	30.000	5.575
LN-33	valve	Poly	1.90E+05	7.10E+02	267.606	1	31.818	5.590
LN-8	bottle	Glass	3.80E+05	7.30E+02	520.548	1	33.636	6.255
LN-4	bottle	Glass	2.00E+05	3.30E+02	606.061	1	35.455	6.407
RH9M	bottle	Glass	1.50E+05	2.10E+02	714.286	1	37.273	6.571
RH9P	Tool	Metal	8.20E+04	1.00E+02	820.000	1	39.091	6.709
LN-1	bottle	Glass	1.40E+06	1.70E+03	823.529	1	40.909	6.714
RH9I	MSM Boot	Poly	9.40E+04	8.90E+01	1056.180	1	42.727	6.962
LN-49	socket	Metal	1.20E+05	9.10E+01	1318.681	1	44.545	7.184
RH9G	Valve	Poly	2.80E+04	1.90E+01	1473.684	1	46.364	7.296
LN-7	tool	Metal	6.00E+04	3.90E+01	1538.462	1	48.182	7.339
RH9F	Valve	Poly	2.00E+05	9.90E+01	2020.202	1	50.000	7.611
RH9H	Light Cord	Poly	1.00E+05	4.90E+01	2040.816	1	51.818	7.621
LN-38	tool	Metal	5.30E+05	2.30E+02	2304.348	1	53.636	7.743
LN-3	bottle	Glass	1.40E+06	6.00E+02	2333.333	1	55.455	7.755
RH9E	Valve	Poly	9.70E+04	4.10E+01	2365.854	1	57.273	7.769
LN-28	bottle	Glass	1.10E+06	4.60E+02	2391.304	1	59.091	7.780
RH9EE	Valve	Poly	5.90E+05	1.90E+02	3105.263	1	60.909	8.041
LN-35	bottle	Poly	1.40E+06	3.30E+02	4242.424	1	62.727	8.353
RH9C	Melt	Poly	1.70E+05	3.30E+01	5151.515	1	64.545	8.547
RH9S	Wipes	Wipes	2.30E+06	4.40E+02	5227.273	1	66.364	8.562
RH9N	glassware	Glass	9.00E+05	1.70E+02	5294.118	1	68.182	8.574
RH9L	bottle	Glass	3.40E+05	5.80E+01	5862.069	1	70.000	8.676
RH9LL	bottle	Glass	1.10E+06	1.80E+02	6111.111	1	71.818	8.718
RH9A	Melt	Poly	1.80E+05	1.70E+01	10588.235	1	73.636	9.267
RH9K	Lid	Poly	1.40E+06	1.30E+02	10769.231	1	75.455	9.284
LN-15	tool	Metal	1.10E+06	8.00E+01	13750.000	1	77.273	9.529
RH9QQ	Wire	Metal	2.00E+06	1.40E+02	14285.714	1	79.091	9.567
RH9D	bckt	Poly	1.30E+06	8.40E+01	15476.190	1	80.909	9.647
RH9KK	Lid	Poly	3.80E+05	1.90E+01	20000.000	1	82.727	9.903
RH9Q	Wire	Metal	6.60E+05	2.80E+01	23571.429	1	84.545	10.068
RH9SS	Wipes	Wipes	2.80E+06	1.10E+02	25454.545	1	86.364	10.145
RH9R	Lid	Metal	1.60E+06	4.00E+01	40000.000	1	88.182	10.597
RH9O	housing	Glass	6.00E+05	1.20E+01	50000.000	1	90.000	10.820
RH9V	Wipes	Wipes	9.40E+06	1.30E+02	72307.692	1	91.818	11.189
RH9T	Wipes	Wipes	2.30E+06	1.00E+01	230000.000	1	93.636	12.346
RH9U	Wipes	Wipes	1.30E+07	1.30E+01	1000000.000	1	95.455	13.816
LN-25	bottle	Glass	1.20E+08	8.30E+01	1445783.133	1	97.273	14.184
RH9AA	Melt	Poly	6.90E+07	1.60E+01	4312500.000	1	99.091	15.277

Pu238/Cs134

Sample ID	Waste Component	Waste Group	Pu238 (Bq/total)	Cs134 (Bq/total)	Pu238/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	3.80E+02	1.20E+04	0.032	1	0.909	-3.452
LN-1	bottle	Glass	4.70E+02	1.70E+03	0.276	1	2.727	-1.286
RH9I	MSM Boot	Poly	3.50E+01	8.90E+01	0.393	1	4.545	-0.933
LN-11	bottle	Glass	1.30E+03	2.90E+03	0.448	1	6.364	-0.802
RH9M	bottle	Glass	1.00E+02	2.10E+02	0.476	1	8.182	-0.742
LN-GL	bottles	Glass	2.70E+05	5.00E+05	0.540	1	10.000	-0.616
LN-6	bottle	Glass	1.70E+03	2.90E+03	0.586	1	11.818	-0.534
RH9H	Light Cord	Poly	2.90E+01	4.90E+01	0.592	1	13.636	-0.525
RH9LL	bottle	Glass	1.20E+02	1.80E+02	0.667	1	15.455	-0.405
RH9SS	Wipes	Wipes	1.10E+02	1.10E+02	1.000	1	17.273	0.000
LN-8	bottle	Glass	7.90E+02	7.30E+02	1.082	1	19.091	0.079
RH9J	Lid	Poly	2.70E+02	2.00E+02	1.350	1	20.909	0.300
LN-26	bottle	Glass	1.10E+03	5.50E+02	2.000	1	22.727	0.693
LN-13	bottle	Glass	1.10E+03	5.40E+02	2.037	1	24.545	0.711
LN-9	bulb	Glass	6.60E+02	3.10E+02	2.129	1	26.364	0.756
LN-3	bottle	Glass	1.40E+03	6.00E+02	2.333	1	28.182	0.847
RH9V	Wipes	Wipes	3.60E+02	1.30E+02	2.769	1	30.000	1.019
LN-4	bottle	Glass	9.80E+02	3.30E+02	2.970	1	31.818	1.088
LN-38	tool	Metal	6.90E+02	2.30E+02	3.000	1	33.636	1.099
LN-28	bottle	Glass	1.40E+03	4.60E+02	3.043	1	35.455	1.113
LN-19	bottle	Glass	1.10E+03	3.30E+02	3.333	1	37.273	1.204
RH9S	Wipes	Wipes	1.50E+03	4.40E+02	3.409	1	39.091	1.226
LN-41	column	Metal	2.00E+03	4.90E+02	4.082	1	40.909	1.406
RH9O	housing	Glass	5.25E+01	1.20E+01	4.375	1	42.727	1.476
LN-49	socket	Metal	4.00E+02	9.10E+01	4.396	1	44.545	1.481
LN-46	can	Metal	1.10E+03	2.50E+02	4.400	1	46.364	1.482
LN-48	tool	Metal	1.60E+03	3.50E+02	4.571	1	48.182	1.520
RH9K	Lid	Poly	6.80E+02	1.30E+02	5.231	1	50.000	1.655
LN-25	bottle	Glass	4.40E+02	8.30E+01	5.301	1	51.818	1.668
LN-36	cell	Metal	2.30E+03	4.10E+02	5.610	1	53.636	1.725
RH9D	bckt	Poly	4.85E+02	8.40E+01	5.774	1	55.455	1.753
RH9R	Lid	Metal	2.40E+02	4.00E+01	6.000	1	57.273	1.792
LN-54	case	Metal	1.40E+03	2.20E+02	6.364	1	59.091	1.851
RH9E	Valve	Poly	3.00E+02	4.10E+01	7.317	1	60.909	1.990
RH9A	Melt	Poly	1.30E+02	1.70E+01	7.647	1	62.727	2.034
RH9L	bottle	Glass	5.00E+02	5.80E+01	8.621	1	64.545	2.154
LN-33	valve	Poly	6.40E+03	7.10E+02	9.014	1	66.364	2.199
RH9P	Tool	Metal	9.90E+02	1.00E+02	9.900	1	68.182	2.293
LN-39	cell	Metal	3.00E+03	3.00E+02	10.000	1	70.000	2.303
RH9F	Valve	Poly	1.00E+03	9.90E+01	10.101	1	71.818	2.313
RH9AA	Melt	Poly	1.70E+02	1.60E+01	10.625	1	73.636	2.363
RH9N	glassware	Glass	1.95E+03	1.70E+02	11.471	1	75.455	2.440
LN-44	cap	Metal	3.10E+03	2.60E+02	11.923	2	79.091	2.478
RH9U	Wipes	Wipes	1.55E+02	1.30E+01	11.923	0	79.091	2.478
RH9C	Melt	Poly	4.20E+02	3.30E+01	12.727	1	80.909	2.544
RH9QQ	Wire	Metal	1.95E+03	1.40E+02	13.929	1	82.727	2.634
RH9Q	Wire	Metal	8.75E+02	2.80E+01	31.250	1	84.545	3.442
RH9EE	Valve	Poly	6.20E+03	1.90E+02	32.632	1	86.364	3.485
RH9T	Wipes	Wipes	3.90E+02	1.00E+01	39.000	1	88.182	3.664
RH9G	Valve	Poly	8.00E+02	1.90E+01	42.105	1	90.000	3.740
LN-35	bottle	Poly	1.40E+04	3.30E+02	42.424	1	91.818	3.748
RH9KK	Lid	Poly	8.50E+02	1.90E+01	44.737	1	93.636	3.801
LN-ML	tool	Metal	1.10E+06	1.40E+04	78.571	1	95.455	4.364
LN-15	tool	Metal	6.30E+03	8.00E+01	78.750	1	97.273	4.366
LN-7	tool	Metal	3.40E+03	3.90E+01	87.179	1	99.091	4.468

Pu*/Cs134

Sample ID	Waste Component	Waste Group	Pu* (Bq/total)	Cs134 (Bq/total)	Pu*/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-ML	tool	Wipes	1.55E+02	1.40E+04	0.011	1	0.909	-4.503
LN-40	hose	Glass	4.60E+02	1.20E+04	0.038	1	2.727	-3.261
LN-1	bottle	Poly	2.90E+02	1.70E+03	0.171	1	4.545	-1.769
LN-11	bottle	Glass	5.10E+02	2.90E+03	0.176	1	6.364	-1.738
LN-39	cell	Poly	5.80E+01	3.00E+02	0.193	1	8.182	-1.643
LN-6	bottle	Metal	5.70E+02	2.90E+03	0.197	1	10.000	-1.627
LN-3	bottle	Wipes	1.20E+02	6.00E+02	0.200	1	11.818	-1.609
LN-13	bottle	Glass	1.20E+02	5.40E+02	0.222	1	13.636	-1.504
LN-9	bulb	Poly	1.10E+02	3.10E+02	0.355	1	15.455	-1.036
LN-8	bottle	Wipes	3.50E+02	7.30E+02	0.479	1	17.273	-0.735
LN-GL	bottles	Metal	2.90E+05	5.00E+05	0.580	1	19.091	-0.545
LN-46	can	Wipes	1.50E+02	2.50E+02	0.600	1	20.909	-0.511
RH9S	Wipes	Wipes	2.90E+02	4.40E+02	0.659	1	22.727	-0.417
LN-33	valve	Poly	4.85E+02	7.10E+02	0.683	1	24.545	-0.381
LN-48	tool	Poly	2.50E+02	3.50E+02	0.714	1	26.364	-0.336
LN-41	column	Metal	4.00E+02	4.90E+02	0.816	1	28.182	-0.203
LN-26	bottle	Metal	4.80E+02	5.50E+02	0.873	1	30.000	-0.136
LN-28	bottle	Metal	6.80E+02	4.60E+02	1.478	1	31.818	0.391
RH9N	glassware	Poly	2.60E+02	1.70E+02	1.529	1	33.636	0.425
LN-35	bottle	Poly	5.20E+02	3.30E+02	1.576	1	35.455	0.455
RH9EE	Valve	Metal	4.00E+02	1.90E+02	2.105	1	37.273	0.744
LN-54	case	Poly	6.20E+02	2.20E+02	2.818	1	39.091	1.036
LN-38	tool	Metal	9.30E+02	2.30E+02	4.043	1	40.909	1.397
LN-44	cap	Metal	1.10E+03	2.60E+02	4.231	1	42.727	1.442
LN-49	socket	Glass	4.00E+02	9.10E+01	4.396	1	44.545	1.481
RH9F	Valve	Poly	5.00E+02	9.90E+01	5.051	1	46.364	1.619
LN-36	cell	Metal	2.10E+03	4.10E+02	5.122	1	48.182	1.634
RH9D	bckt	Poly	4.40E+02	8.40E+01	5.238	1	50.000	1.656
RH9H	Light Cord	Poly	2.60E+02	4.90E+01	5.306	1	51.818	1.669
RH9A	Melt	Poly	9.10E+01	1.70E+01	5.353	1	53.636	1.678
RH9J	Lid	Glass	1.10E+03	2.00E+02	5.500	1	55.455	1.705
RH9I	MSM Boot	Poly	5.15E+02	8.90E+01	5.787	1	57.273	1.756
LN-19	bottle	Glass	2.00E+03	3.30E+02	6.061	1	59.091	1.802
RH9C	Melt	Glass	3.00E+02	3.30E+01	9.091	1	60.909	2.207
RH9LL	bottle	Metal	1.80E+03	1.80E+02	10.000	1	62.727	2.303
RH9KK	Lid	Metal	2.15E+02	1.90E+01	11.316	1	64.545	2.426
RH9G	Valve	Poly	3.50E+02	1.90E+01	18.421	1	66.364	2.913
LN-4	bottle	Glass	6.90E+03	3.30E+02	20.909	1	68.182	3.040
RH9E	Valve	Metal	9.50E+02	4.10E+01	23.171	1	70.000	3.143
RH9M	bottle	Glass	4.90E+03	2.10E+02	23.333	1	71.818	3.150
RH9L	bottle	Metal	1.40E+03	5.80E+01	24.138	1	73.636	3.184
RH9SS	Wipes	Metal	3.80E+03	1.10E+02	34.545	1	75.455	3.542
RH9K	Lid	Poly	5.50E+03	1.30E+02	42.308	1	77.273	3.745
LN-25	bottle	Poly	3.60E+03	8.30E+01	43.373	1	79.091	3.770
RH9QQ	Wire	Glass	6.30E+03	1.40E+02	45.000	1	80.909	3.807
RH9P	Tool	Glass	4.70E+03	1.00E+02	47.000	1	82.727	3.850
RH9U	Wipes	Metal	8.75E+02	1.30E+01	67.308	1	84.545	4.209
RH9V	Wipes	Glass	8.90E+03	1.30E+02	68.462	1	86.364	4.226
RH9AA	Melt	Glass	1.10E+03	1.60E+01	68.750	1	88.182	4.230
LN-7	tool	Glass	4.00E+03	3.90E+01	102.564	1	90.000	4.630
RH9R	Lid	Glass	6.60E+03	4.00E+01	165.000	1	91.818	5.106
RH9Q	Wire	Metal	6.20E+03	2.80E+01	221.429	1	93.636	5.400
RH9O	housing	Glass	4.00E+03	1.20E+01	333.333	1	95.455	5.809
RH9T	Wipes	Glass	6.30E+03	1.00E+01	630.000	1	97.273	6.446
LN-15	tool	Glass	3.20E+05	8.00E+01	4000.000	1	99.091	8.294

Pu242/Cs134

Sample ID	Waste Component	Waste Group	Pu242 (Bq/total)	Cs134 (Bq/total)	Pu242/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	8.70E+00	1.20E+04	0.001	1	0.909	-7.229
LN-6	bottle	Glass	1.60E+01	2.90E+03	0.006	1	2.727	-5.200
LN-11	bottle	Glass	2.00E+01	2.90E+03	0.007	1	4.545	-4.977
LN-GL	bottles	Glass	4.20E+03	5.00E+05	0.008	1	6.364	-4.780
LN-1	bottle	Glass	2.00E+01	1.70E+03	0.012	1	8.182	-4.443
LN-3	bottle	Glass	1.50E+01	6.00E+02	0.025	1	10.000	-3.689
LN-39	cell	Metal	9.30E+00	3.00E+02	0.031	1	11.818	-3.474
LN-13	bottle	Glass	2.00E+01	5.40E+02	0.037	2	15.455	-3.296
LN-48	tool	Metal	1.30E+01	3.50E+02	0.037	0	15.455	-3.293
LN-36	cell	Metal	2.40E+01	4.10E+02	0.059	1	17.273	-2.838
LN-8	bottle	Glass	4.40E+01	7.30E+02	0.060	1	19.091	-2.809
LN-4	bottle	Glass	2.00E+01	3.30E+02	0.061	1	20.909	-2.803
LN-41	column	Metal	3.30E+01	4.90E+02	0.067	1	22.727	-2.698
LN-46	can	Metal	1.70E+01	2.50E+02	0.068	1	24.545	-2.688
LN-33	valve	Poly	5.00E+01	7.10E+02	0.070	1	26.364	-2.653
LN-25	bottle	Glass	8.00E+00	8.30E+01	0.096	1	28.182	-2.339
LN-19	bottle	Glass	3.20E+01	3.30E+02	0.097	1	30.000	-2.333
LN-28	bottle	Glass	4.90E+01	4.60E+02	0.107	1	31.818	-2.239
LN-26	bottle	Glass	6.50E+01	5.50E+02	0.118	1	33.636	-2.136
LN-38	tool	Metal	2.80E+01	2.30E+02	0.122	1	35.455	-2.106
LN-9	bulb	Glass	3.90E+01	3.10E+02	0.126	1	37.273	-2.073
LN-54	case	Metal	3.40E+01	2.20E+02	0.155	1	39.091	-1.867
LN-44	cap	Metal	4.60E+01	2.60E+02	0.177	1	40.909	-1.732
LN-35	bottle	Poly	2.00E+02	3.30E+02	0.606	1	42.727	-0.501
RH9LL	bottle	Glass	1.20E+02	1.80E+02	0.667	1	44.545	-0.405
LN-15	tool	Metal	6.60E+01	8.00E+01	0.825	1	46.364	-0.192
LN-49	socket	Metal	8.20E+01	9.10E+01	0.901	1	48.182	-0.104
LN-ML	tool	Metal	1.30E+04	1.40E+04	0.929	1	50.000	-0.074
LN-7	tool	Metal	4.80E+01	3.90E+01	1.231	1	51.818	0.208
RH9J	Lid	Poly	5.20E+02	2.00E+02	2.600	1	53.636	0.956
RH9S	Wipes	Wipes	1.50E+03	4.40E+02	3.409	1	55.455	1.226
RH9O	housing	Glass	5.25E+01	1.20E+01	4.375	1	57.273	1.476
RH9V	Wipes	Wipes	5.85E+02	1.30E+02	4.500	1	59.091	1.504
RH9M	bottle	Glass	1.00E+03	2.10E+02	4.762	1	60.909	1.561
RH9R	Lid	Metal	2.15E+02	4.00E+01	5.375	1	62.727	1.682
RH9SS	Wipes	Wipes	6.10E+02	1.10E+02	5.545	1	64.545	1.713
RH9AA	Melt	Poly	9.10E+01	1.60E+01	5.688	1	66.364	1.738
RH9D	bckt	Poly	4.85E+02	8.40E+01	5.774	1	68.182	1.753
RH9E	Valve	Poly	2.60E+02	4.10E+01	6.341	1	70.000	1.847
RH9A	Melt	Poly	1.10E+02	1.70E+01	6.471	1	71.818	1.867
RH9I	MSM Boot	Poly	6.35E+02	8.90E+01	7.135	1	73.636	1.965
RH9K	Lid	Poly	1.10E+03	1.30E+02	8.462	1	75.455	2.136
RH9P	Tool	Metal	9.90E+02	1.00E+02	9.900	1	77.273	2.293
RH9F	Valve	Poly	1.00E+03	9.90E+01	10.101	1	79.091	2.313
RH9L	bottle	Glass	6.00E+02	5.80E+01	10.345	1	80.909	2.336
RH9H	Light Cord	Poly	5.15E+02	4.90E+01	10.510	1	82.727	2.352
RH9C	Melt	Poly	3.50E+02	3.30E+01	10.606	1	84.545	2.361
RH9N	glassware	Glass	1.95E+03	1.70E+02	11.471	1	86.364	2.440
RH9U	Wipes	Wipes	1.55E+02	1.30E+01	11.923	1	88.182	2.478
RH9QQ	Wire	Metal	1.95E+03	1.40E+02	13.929	1	90.000	2.634
RH9G	Valve	Poly	2.90E+02	1.90E+01	15.263	1	91.818	2.725
RH9T	Wipes	Wipes	1.65E+02	1.00E+01	16.500	1	93.636	2.803
RH9KK	Lid	Poly	5.75E+02	1.90E+01	30.263	1	95.455	3.410
RH9Q	Wire	Metal	8.75E+02	2.80E+01	31.250	1	97.273	3.442
RH9EE	Valve	Poly	6.20E+03	1.90E+02	32.632	1	99.091	3.485

Am241/Cs134

Sample ID	Waste Component	Waste Group	Am241 (Bq/total)	Cs134 (Bq/total)	Am241/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	1.10E+04	1.20E+04	0.917	1	0.909	-0.087
LN-GL	bottles	Glass	6.20E+05	5.00E+05	1.240	1	2.727	0.215
LN-11	bottle	Glass	6.20E+03	2.90E+03	2.138	1	4.545	0.760
LN-6	bottle	Glass	7.10E+03	2.90E+03	2.448	1	6.364	0.895
LN-26	bottle	Glass	1.70E+03	5.50E+02	3.091	1	8.182	1.128
RH9J	Lid	Poly	7.20E+02	2.00E+02	3.600	1	10.000	1.281
LN-3	bottle	Glass	2.50E+03	6.00E+02	4.167	1	11.818	1.427
LN-1	bottle	Glass	7.30E+03	1.70E+03	4.294	1	13.636	1.457
LN-8	bottle	Glass	3.20E+03	7.30E+02	4.384	1	15.455	1.478
RH9O	housing	Glass	5.40E+01	1.20E+01	4.500	1	17.273	1.504
RH9F	Valve	Poly	4.60E+02	9.90E+01	4.646	1	19.091	1.536
RH9LL	bottle	Glass	8.50E+02	1.80E+02	4.722	1	20.909	1.552
RH9S	Wipes	Wipes	2.10E+03	4.40E+02	4.773	1	22.727	1.563
LN-28	bottle	Glass	2.20E+03	4.60E+02	4.783	1	24.545	1.565
LN-9	bulb	Glass	1.50E+03	3.10E+02	4.839	1	26.364	1.577
LN-13	bottle	Glass	2.80E+03	5.40E+02	5.185	1	28.182	1.646
RH9R	Lid	Metal	2.20E+02	4.00E+01	5.500	1	30.000	1.705
RH9SS	Wipes	Wipes	6.20E+02	1.10E+02	5.636	1	31.818	1.729
LN-19	bottle	Glass	1.90E+03	3.30E+02	5.758	1	33.636	1.751
RH9V	Wipes	Wipes	7.60E+02	1.30E+02	5.846	1	35.455	1.766
LN-4	bottle	Glass	2.20E+03	3.30E+02	6.667	2	39.091	1.897
RH9M	bottle	Glass	1.40E+03	2.10E+02	6.667	0	39.091	1.897
LN-38	tool	Metal	1.70E+03	2.30E+02	7.391	1	40.909	2.000
LN-46	can	Metal	2.00E+03	2.50E+02	8.000	1	42.727	2.079
RH9G	Valve	Poly	1.60E+02	1.90E+01	8.421	1	44.545	2.131
LN-44	cap	Metal	2.20E+03	2.60E+02	8.462	1	46.364	2.136
RH9E	Valve	Poly	3.50E+02	4.10E+01	8.537	1	48.182	2.144
RH9T	Wipes	Wipes	8.70E+01	1.00E+01	8.700	1	50.000	2.163
LN-49	socket	Metal	8.90E+02	9.10E+01	9.780	1	51.818	2.280
RH9K	Lid	Poly	1.30E+03	1.30E+02	10.000	1	53.636	2.303
RH9I	MSM Boot	Poly	9.10E+02	8.90E+01	10.225	1	55.455	2.325
LN-48	tool	Metal	3.70E+03	3.50E+02	10.571	1	57.273	2.358
RH9AA	Melt	Poly	1.70E+02	1.60E+01	10.625	1	59.091	2.363
RH9D	bckt	Poly	1.00E+03	8.40E+01	11.905	1	60.909	2.477
RH9A	Melt	Poly	2.20E+02	1.70E+01	12.941	1	62.727	2.560
RH9KK	Lid	Poly	2.50E+02	1.90E+01	13.158	1	64.545	2.577
RH9L	bottle	Glass	8.20E+02	5.80E+01	14.138	1	66.364	2.649
LN-41	column	Metal	7.20E+03	4.90E+02	14.694	1	68.182	2.687
RH9EE	Valve	Poly	2.80E+03	1.90E+02	14.737	1	70.000	2.690
RH9H	Light Cord	Poly	9.40E+02	4.90E+01	19.184	1	71.818	2.954
LN-33	valve	Poly	1.50E+04	7.10E+02	21.127	1	73.636	3.051
RH9P	Tool	Metal	2.20E+03	1.00E+02	22.000	1	75.455	3.091
RH9C	Melt	Poly	7.40E+02	3.30E+01	22.424	1	77.273	3.110
LN-54	case	Metal	5.20E+03	2.20E+02	23.636	1	79.091	3.163
RH9U	Wipes	Wipes	3.20E+02	1.30E+01	24.615	1	80.909	3.203
RH9QQ	Wire	Metal	5.60E+03	1.40E+02	40.000	1	82.727	3.689
LN-25	bottle	Glass	4.90E+03	8.30E+01	59.036	1	84.545	4.078
LN-7	tool	Metal	2.50E+03	3.90E+01	64.103	1	86.364	4.160
RH9N	glassware	Glass	1.10E+04	1.70E+02	64.706	1	88.182	4.170
LN-ML	tool	Metal	9.30E+05	1.40E+04	66.429	1	90.000	4.196
LN-15	tool	Metal	5.90E+03	8.00E+01	73.750	1	91.818	4.301
RH9Q	Wire	Metal	3.00E+03	2.80E+01	107.143	1	93.636	4.674
LN-35	bottle	Poly	5.80E+04	3.30E+02	175.758	1	95.455	5.169
LN-36	cell	Metal	8.30E+04	4.10E+02	202.439	1	97.273	5.310
LN-39	cell	Metal	1.10E+05	3.00E+02	366.667	1	99.091	5.904

Am243/Cs134

Sample ID	Waste Component	Waste Group	Am243 (Bq/total)	Cs134 (Bq/total)	Am243/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-11	bottle	Glass	4.10E+02	2.90E+03	0.141	1	0.909	-1.956
LN-GL	bottles	Glass	7.10E+04	5.00E+05	0.142	1	2.727	-1.952
RH9J	Lid	Poly	2.90E+01	2.00E+02	0.145	1	4.545	-1.931
RH9LL	bottle	Glass	4.20E+01	1.80E+02	0.233	1	6.364	-1.455
LN-6	bottle	Glass	6.80E+02	2.90E+03	0.234	1	8.182	-1.450
RH9F	Valve	Poly	2.40E+01	9.90E+01	0.242	1	10.000	-1.417
RH9R	Lid	Metal	1.00E+01	4.00E+01	0.250	1	11.818	-1.386
LN-1	bottle	Glass	4.50E+02	1.70E+03	0.265	1	13.636	-1.329
RH9A	Melt	Poly	5.10E+00	1.70E+01	0.300	1	15.455	-1.204
RH9SS	Wipes	Wipes	3.60E+01	1.10E+02	0.327	1	17.273	-1.117
RH9D	bckt	Poly	2.80E+01	8.40E+01	0.333	2	20.909	-1.099
RH9O	housing	Glass	4.00E+00	1.20E+01	0.333	0	20.909	-1.099
RH9M	bottle	Glass	8.90E+01	2.10E+02	0.424	2	24.545	-0.858
LN-19	bottle	Glass	1.40E+02	3.30E+02	0.424	0	24.545	-0.857
LN-41	column	Metal	2.10E+02	4.90E+02	0.429	2	28.182	-0.847
LN-48	tool	Metal	1.50E+02	3.50E+02	0.429	0	28.182	-0.847
LN-26	bottle	Glass	2.40E+02	5.50E+02	0.436	1	30.000	-0.829
LN-46	can	Metal	1.10E+02	2.50E+02	0.440	1	31.818	-0.821
RH9G	Valve	Poly	8.90E+00	1.90E+01	0.468	1	33.636	-0.758
RH9I	MSM Boot	Poly	4.20E+01	8.90E+01	0.472	1	35.455	-0.751
LN-40	hose	Poly	5.80E+03	1.20E+04	0.483	1	37.273	-0.727
LN-8	bottle	Glass	3.70E+02	7.30E+02	0.507	1	39.091	-0.680
RH9V	Wipes	Wipes	6.90E+01	1.30E+02	0.531	1	40.909	-0.633
LN-13	bottle	Glass	3.00E+02	5.40E+02	0.556	1	42.727	-0.588
RH9KK	Lid	Poly	1.10E+01	1.90E+01	0.579	1	44.545	-0.547
RH9L	bottle	Glass	3.40E+01	5.80E+01	0.586	1	46.364	-0.534
RH9N	glassware	Glass	1.00E+02	1.70E+02	0.588	1	48.182	-0.531
RH9U	Wipes	Wipes	8.00E+00	1.30E+01	0.615	1	50.000	-0.486
RH9K	Lid	Poly	8.10E+01	1.30E+02	0.623	1	51.818	-0.473
LN-28	bottle	Glass	2.90E+02	4.60E+02	0.630	1	53.636	-0.461
RH9C	Melt	Poly	2.10E+01	3.30E+01	0.636	1	55.455	-0.452
RH9AA	Melt	Poly	1.10E+01	1.60E+01	0.688	1	57.273	-0.375
RH9S	Wipes	Wipes	3.20E+02	4.40E+02	0.727	1	59.091	-0.318
LN-44	cap	Metal	1.90E+02	2.60E+02	0.731	1	60.909	-0.314
LN-38	tool	Metal	1.70E+02	2.30E+02	0.739	1	62.727	-0.302
RH9T	Wipes	Wipes	7.50E+00	1.00E+01	0.750	1	64.545	-0.288
RH9E	Valve	Poly	3.20E+01	4.10E+01	0.780	1	66.364	-0.248
RH9QQ	Wire	Metal	1.20E+02	1.40E+02	0.857	1	68.182	-0.154
RH9H	Light Cord	Poly	4.60E+01	4.90E+01	0.939	1	70.000	-0.063
LN-3	bottle	Glass	5.70E+02	6.00E+02	0.950	1	71.818	-0.051
RH9P	Tool	Metal	9.60E+01	1.00E+02	0.960	1	73.636	-0.041
LN-49	socket	Metal	8.80E+01	9.10E+01	0.967	1	75.455	-0.034
LN-9	bulb	Glass	3.10E+02	3.10E+02	1.000	1	77.273	0.000
RH9EE	Valve	Poly	2.10E+02	1.90E+02	1.105	1	79.091	0.100
LN-35	bottle	Poly	3.70E+02	3.30E+02	1.121	1	80.909	0.114
LN-4	bottle	Glass	4.10E+02	3.30E+02	1.242	1	82.727	0.217
LN-54	case	Metal	3.20E+02	2.20E+02	1.455	1	84.545	0.375
RH9Q	Wire	Metal	4.30E+01	2.80E+01	1.536	1	86.364	0.429
LN-33	valve	Poly	1.30E+03	7.10E+02	1.831	1	88.182	0.605
LN-7	tool	Metal	8.00E+01	3.90E+01	2.051	1	90.000	0.718
LN-36	cell	Metal	1.00E+03	4.10E+02	2.439	1	91.818	0.892
LN-25	bottle	Glass	2.20E+02	8.30E+01	2.651	1	93.636	0.975
LN-ML	tool	Metal	4.90E+04	1.40E+04	3.500	1	95.455	1.253
LN-15	tool	Metal	2.90E+02	8.00E+01	3.625	1	97.273	1.288
LN-39	cell	Metal	1.20E+03	3.00E+02	4.000	1	99.091	1.386

Cf252/Cs134

Sample ID	Waste Component	Waste Group	Cf252 (Bq/total)	Cs134 (Bq/total)	Cf252/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9S	Wipes	Wipes	3.90E+02	4.40E+02	0.886	1	0.909	-0.121
RH9LL	bottle	Glass	1.80E+02	1.80E+02	1.000	1	2.727	0.000
LN-6	bottle	Glass	3.20E+03	2.90E+03	1.103	1	4.545	0.098
LN-40	hose	Poly	1.80E+04	1.20E+04	1.500	1	6.364	0.405
LN-11	bottle	Glass	5.50E+03	2.90E+03	1.897	1	8.182	0.640
LN-GL	bottles	Glass	1.30E+06	5.00E+05	2.600	1	10.000	0.956
LN-8	bottle	Glass	2.80E+03	7.30E+02	3.836	1	11.818	1.344
LN-3	bottle	Glass	2.60E+03	6.00E+02	4.333	1	13.636	1.466
LN-28	bottle	Glass	2.10E+03	4.60E+02	4.565	1	15.455	1.518
LN-44	cap	Metal	1.20E+03	2.60E+02	4.615	1	17.273	1.529
LN-13	bottle	Glass	2.50E+03	5.40E+02	4.630	1	19.091	1.532
LN-9	bulb	Glass	1.60E+03	3.10E+02	5.161	1	20.909	1.641
LN-19	bottle	Glass	2.10E+03	3.30E+02	6.364	1	22.727	1.851
LN-48	tool	Metal	2.50E+03	3.50E+02	7.143	1	24.545	1.966
LN-46	can	Metal	1.80E+03	2.50E+02	7.200	1	26.364	1.974
LN-4	bottle	Glass	2.50E+03	3.30E+02	7.576	1	28.182	2.025
RH9G	Valve	Poly	1.50E+02	1.90E+01	7.895	1	30.000	2.066
RH9F	Valve	Poly	8.10E+02	9.90E+01	8.182	1	31.818	2.102
LN-38	tool	Metal	1.90E+03	2.30E+02	8.261	1	33.636	2.112
LN-49	socket	Metal	7.80E+02	9.10E+01	8.571	1	35.455	2.148
LN-1	bottle	Glass	1.60E+04	1.70E+03	9.412	1	37.273	2.242
RH9R	Lid	Metal	3.90E+02	4.00E+01	9.750	1	39.091	2.277
RH9D	bckt	Poly	8.80E+02	8.40E+01	10.476	1	40.909	2.349
LN-26	bottle	Glass	5.80E+03	5.50E+02	10.545	1	42.727	2.356
RH9I	MSM Boot	Poly	9.40E+02	8.90E+01	10.562	1	44.545	2.357
RH9SS	Wipes	Wipes	1.20E+03	1.10E+02	10.909	1	46.364	2.390
LN-36	cell	Metal	4.50E+03	4.10E+02	10.976	1	48.182	2.396
LN-54	case	Metal	2.50E+03	2.20E+02	11.364	1	50.000	2.430
RH9P	Tool	Metal	1.20E+03	1.00E+02	12.000	1	51.818	2.485
LN-41	column	Metal	6.00E+03	4.90E+02	12.245	1	53.636	2.505
LN-25	bottle	Glass	1.10E+03	8.30E+01	13.253	1	55.455	2.584
RH9H	Light Cord	Poly	7.00E+02	4.90E+01	14.286	1	57.273	2.659
RH9AA	Melt	Poly	2.30E+02	1.60E+01	14.375	1	59.091	2.665
RH9M	bottle	Glass	3.20E+03	2.10E+02	15.238	1	60.909	2.724
RH9V	Wipes	Wipes	2.10E+03	1.30E+02	16.154	1	62.727	2.782
RH9EE	Valve	Poly	3.10E+03	1.90E+02	16.316	1	64.545	2.792
RH9A	Melt	Poly	2.80E+02	1.70E+01	16.471	1	66.364	2.802
RH9N	glassware	Glass	2.90E+03	1.70E+02	17.059	1	68.182	2.837
LN-39	cell	Metal	5.20E+03	3.00E+02	17.333	1	70.000	2.853
RH9E	Valve	Poly	7.20E+02	4.10E+01	17.561	1	71.818	2.866
LN-33	valve	Poly	1.30E+04	7.10E+02	18.310	1	73.636	2.907
RH9C	Melt	Poly	6.60E+02	3.30E+01	20.000	2	77.273	2.996
RH9T	Wipes	Wipes	2.00E+02	1.00E+01	20.000	0	77.273	2.996
RH9K	Lid	Poly	3.10E+03	1.30E+02	23.846	1	79.091	3.172
RH9QQ	Wire	Metal	3.40E+03	1.40E+02	24.286	1	80.909	3.190
RH9U	Wipes	Wipes	3.20E+02	1.30E+01	24.615	1	82.727	3.203
RH9Q	Wire	Metal	8.40E+02	2.80E+01	30.000	1	84.545	3.401
RH9L	bottle	Glass	1.90E+03	5.80E+01	32.759	1	86.364	3.489
RH9J	Lid	Poly	7.10E+03	2.00E+02	35.500	1	88.182	3.570
LN-35	bottle	Poly	2.10E+04	3.30E+02	63.636	1	90.000	4.153
RH9O	housing	Glass	1.40E+03	1.20E+01	116.667	1	91.818	4.759
LN-7	tool	Metal	4.80E+03	3.90E+01	123.077	1	93.636	4.813
LN-15	tool	Metal	1.00E+04	8.00E+01	125.000	1	95.455	4.828
RH9KK	Lid	Poly	2.70E+03	1.90E+01	142.105	1	97.273	4.957
LN-ML	tool	Metal	2.00E+06	1.40E+04	142.857	1	99.091	4.962

Cm242/Cs134

Sample ID	Waste Component	Waste Group	Cm242 (Bq/total)	Cs134 (Bq/total)	Cm242/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottle	Glass	3.10E+03	5.00E+05	0.006	1	0.909	-5.083
LN-11	bottle	Glass	1.20E+02	2.90E+03	0.041	1	2.727	-3.185
LN-ML	Wipes	Wipes	7.30E+02	1.40E+04	0.052	1	4.545	-2.954
LN-13	housing	Glass	5.30E+01	5.40E+02	0.098	1	6.364	-2.321
LN-40	tool	Metal	1.50E+03	1.20E+04	0.125	1	8.182	-2.079
LN-41	Wipes	Wipes	2.10E+02	4.90E+02	0.429	1	10.000	-0.847
LN-28	socket	Metal	3.00E+02	4.60E+02	0.652	1	11.818	-0.427
LN-46	Valve	Poly	1.70E+02	2.50E+02	0.680	1	13.636	-0.386
LN-19	can	Metal	3.20E+02	3.30E+02	0.970	1	15.455	-0.031
RH9EE	Melt	Poly	1.90E+02	1.90E+02	1.000	1	17.273	0.000
LN-49	Valve	Poly	1.10E+02	9.10E+01	1.209	1	19.091	0.190
RH9J	Lid	Metal	3.40E+02	2.00E+02	1.700	1	20.909	0.531
LN-35	bottle	Glass	6.10E+02	3.30E+02	1.848	1	22.727	0.614
LN-9	Valve	Poly	5.90E+02	3.10E+02	1.903	1	24.545	0.644
LN-54	Light Cord	Poly	4.30E+02	2.20E+02	1.955	1	26.364	0.670
LN-8	Lid	Poly	2.20E+03	7.30E+02	3.014	1	28.182	1.103
LN-26	column	Metal	1.70E+03	5.50E+02	3.091	1	30.000	1.128
LN-38	bckt	Poly	8.00E+02	2.30E+02	3.478	1	31.818	1.247
LN-4	bottle	Glass	1.20E+03	3.30E+02	3.636	1	33.636	1.291
LN-7	Melt	Poly	1.70E+02	3.90E+01	4.359	1	35.455	1.472
LN-39	tool	Metal	1.40E+03	3.00E+02	4.667	1	37.273	1.540
RH9K	Tool	Metal	8.00E+02	1.30E+02	6.154	1	39.091	1.817
LN-48	case	Metal	2.30E+03	3.50E+02	6.571	1	40.909	1.883
LN-36	bottle	Glass	2.70E+03	4.10E+02	6.585	1	42.727	1.885
LN-1	hose	Poly	1.30E+04	1.70E+03	7.647	1	44.545	2.034
RH9A	Wipes	Wipes	1.50E+02	1.70E+01	8.824	1	46.364	2.177
LN-3	bottle	Glass	5.80E+03	6.00E+02	9.667	1	48.182	2.269
RH9D	Wipes	Wipes	9.50E+02	8.40E+01	11.310	1	50.000	2.426
RH9E	Melt	Poly	5.30E+02	4.10E+01	12.927	1	51.818	2.559
RH9S	tool	Metal	5.70E+03	4.40E+02	12.955	1	53.636	2.561
LN-33	valve	Poly	9.40E+03	7.10E+02	13.239	1	55.455	2.583
RH9AA	Wipes	Wipes	2.90E+02	1.60E+01	18.125	1	57.273	2.897
RH9SS	Lid	Poly	2.40E+03	1.10E+02	21.818	1	59.091	3.083
RH9C	MSM Boot	Poly	7.60E+02	3.30E+01	23.030	1	60.909	3.137
RH9F	bottle	Glass	2.30E+03	9.90E+01	23.232	1	62.727	3.146
RH9I	bottle	Glass	2.10E+03	8.90E+01	23.596	1	64.545	3.161
RH9N	cell	Metal	5.00E+03	1.70E+02	29.412	1	66.364	3.381
RH9LL	bulb	Glass	6.40E+03	1.80E+02	35.556	1	68.182	3.571
RH9M	cell	Metal	7.80E+03	2.10E+02	37.143	1	70.000	3.615
RH9P	Wire	Metal	4.00E+03	1.00E+02	40.000	1	71.818	3.689
RH9L	glassware	Glass	2.40E+03	5.80E+01	41.379	1	73.636	3.723
LN-44	bottle	Glass	1.60E+04	2.60E+02	61.538	1	75.455	4.120
RH9H	bottle	Glass	3.60E+03	4.90E+01	73.469	1	77.273	4.297
RH9R	cap	Metal	4.10E+03	4.00E+01	102.500	1	79.091	4.630
RH9KK	bottle	Glass	2.00E+03	1.90E+01	105.263	1	80.909	4.656
LN-25	bottle	Glass	8.80E+03	8.30E+01	106.024	1	82.727	4.664
RH9O	bottle	Glass	1.30E+03	1.20E+01	108.333	1	84.545	4.685
RH9V	Valve	Poly	1.60E+04	1.30E+02	123.077	1	86.364	4.813
RH9Q	tool	Metal	3.80E+03	2.80E+01	135.714	2	90.000	4.911
RH9QQ	bottle	Poly	1.90E+04	1.40E+02	135.714	0	90.000	4.911
LN-6	tool	Metal	4.10E+05	2.90E+03	141.379	1	91.818	4.951
RH9T	Wire	Metal	1.60E+03	1.00E+01	160.000	1	93.636	5.075
RH9U	Lid	Poly	2.20E+03	1.30E+01	169.231	1	95.455	5.131
RH9G	bottle	Glass	3.70E+03	1.90E+01	194.737	1	97.273	5.272
LN-15	bottles	Glass	5.00E+05	8.00E+01	6.250.000	1	99.091	8.740

Cm246/Cs134

Sample ID	Waste Component	Waste Group	Cm246 (Bq/total)	Cs134 (Bq/total)	Cm246/Cs134 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9LL	bottle	Glass	1.20E+02	1.80E+02	0.667	1	0.909	-0.405
LN-40	hose	Poly	1.45E+04	1.20E+04	1.208	1	2.727	0.189
RH9V	Wipes	Wipes	1.80E+02	1.30E+02	1.385	1	4.545	0.325
LN-46	can	Metal	3.80E+02	2.50E+02	1.520	1	6.364	0.419
LN-GL	bottles	Glass	1.20E+06	5.00E+05	2.400	1	8.182	0.875
RH9K	Lid	Poly	3.30E+02	1.30E+02	2.538	1	10.000	0.932
RH9J	Lid	Poly	5.20E+02	2.00E+02	2.600	1	11.818	0.956
RH9EE	Valve	Poly	6.20E+02	1.90E+02	3.263	1	13.636	1.183
RH9S	Wipes	Wipes	1.50E+03	4.40E+02	3.409	1	15.455	1.226
LN-38	tool	Metal	8.40E+02	2.30E+02	3.652	1	17.273	1.295
LN-11	bottle	Glass	1.10E+04	2.90E+03	3.793	1	19.091	1.333
RH9F	Valve	Poly	4.00E+02	9.90E+01	4.040	1	20.909	1.396
RH9O	housing	Glass	5.25E+01	1.20E+01	4.375	1	22.727	1.476
RH9M	bottle	Glass	1.00E+03	2.10E+02	4.762	1	24.545	1.561
RH9R	Lid	Metal	2.15E+02	4.00E+01	5.375	1	26.364	1.682
RH9SS	Wipes	Wipes	6.10E+02	1.10E+02	5.545	1	28.182	1.713
RH9AA	Melt	Poly	9.10E+01	1.60E+01	5.688	1	30.000	1.738
RH9D	bckt	Poly	4.85E+02	8.40E+01	5.774	1	31.818	1.753
RH9E	Valve	Poly	2.60E+02	4.10E+01	6.341	1	33.636	1.847
LN-1	bottle	Glass	1.10E+04	1.70E+03	6.471	2	37.273	1.867
RH9A	Melt	Poly	1.10E+02	1.70E+01	6.471	0	37.273	1.867
RH9I	MSM Boot	Poly	6.30E+02	8.90E+01	7.079	1	39.091	1.957
LN-6	bottle	Glass	2.30E+04	2.90E+03	7.931	1	40.909	2.071
LN-54	case	Metal	1.80E+03	2.20E+02	8.182	1	42.727	2.102
LN-41	column	Metal	4.80E+03	4.90E+02	9.796	1	44.545	2.282
RH9P	Tool	Metal	9.90E+02	1.00E+02	9.900	1	46.364	2.293
RH9L	bottle	Glass	6.00E+02	5.80E+01	10.345	1	48.182	2.336
RH9H	Light Cord	Poly	5.15E+02	4.90E+01	10.510	1	50.000	2.352
RH9C	Melt	Poly	3.50E+02	3.30E+01	10.606	1	51.818	2.361
LN-48	tool	Metal	3.90E+03	3.50E+02	11.143	1	53.636	2.411
RH9N	glassware	Glass	1.95E+03	1.70E+02	11.471	1	55.455	2.440
RH9U	Wipes	Wipes	1.55E+02	1.30E+01	11.923	1	57.273	2.478
LN-49	socket	Metal	1.20E+03	9.10E+01	13.187	1	59.091	2.579
LN-44	cap	Metal	3.50E+03	2.60E+02	13.462	1	60.909	2.600
RH9QQ	Wire	Metal	1.95E+03	1.40E+02	13.929	1	62.727	2.634
RH9G	Valve	Poly	2.90E+02	1.90E+01	15.263	1	64.545	2.725
RH9T	Wipes	Wipes	1.60E+02	1.00E+01	16.000	1	66.364	2.773
LN-33	valve	Poly	1.40E+04	7.10E+02	19.718	1	68.182	2.982
LN-8	bottle	Glass	1.60E+04	7.30E+02	21.918	1	70.000	3.087
LN-28	bottle	Glass	1.10E+04	4.60E+02	23.913	1	71.818	3.174
LN-26	bottle	Glass	1.45E+04	5.50E+02	26.364	1	73.636	3.272
LN-19	bottle	Glass	9.05E+03	3.30E+02	27.424	1	75.455	3.311
RH9KK	Lid	Poly	5.75E+02	1.90E+01	30.263	1	77.273	3.410
RH9Q	Wire	Metal	8.75E+02	2.80E+01	31.250	1	79.091	3.442
LN-25	bottle	Glass	2.70E+03	8.30E+01	32.530	1	80.909	3.482
LN-4	bottle	Glass	1.30E+04	3.30E+02	39.394	1	82.727	3.674
LN-15	tool	Metal	3.30E+03	8.00E+01	41.250	1	84.545	3.720
LN-13	bottle	Glass	2.30E+04	5.40E+02	42.593	1	86.364	3.752
LN-35	bottle	Poly	1.50E+04	3.30E+02	45.455	1	88.182	3.817
LN-3	bottle	Glass	2.85E+04	6.00E+02	47.500	1	90.000	3.861
LN-ML	tool	Metal	7.30E+05	1.40E+04	52.143	1	91.818	3.954
LN-7	tool	Metal	2.10E+03	3.90E+01	53.846	1	93.636	3.986
LN-9	bulb	Glass	2.05E+04	3.10E+02	66.129	1	95.455	4.192
LN-36	cell	Metal	2.90E+04	4.10E+02	70.732	1	97.273	4.259
LN-39	cell	Metal	3.90E+04	3.00E+02	130.000	1	99.091	4.868

C5. Activity ratios of alpha emitting radionuclides and Eu-154

Cm244/Eu154

Sample ID	Waste Component	Waste Group	Cm244 (Bq/total)	Eu154 (Bq/total)	Cm244/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottles	Glass	1.50E+04	3.90E+05	0.038	1	0.909	-3.258
LN-ML	tool	Metal	5.50E+04	5.20E+05	0.106	1	2.727	-2.246
LN-40	hose	Poly	1.50E+04	4.10E+04	0.366	1	4.545	-1.006
LN-13	bottle	Glass	3.40E+03	1.30E+03	2.615	1	6.364	0.961
LN-11	bottle	Glass	1.10E+04	3.40E+03	3.235	1	8.182	1.174
LN-39	cell	Metal	8.30E+03	1.50E+03	5.533	1	10.000	1.711
LN-36	cell	Metal	1.00E+04	1.60E+03	6.250	1	11.818	1.833
LN-33	valve	Poly	1.90E+05	1.70E+04	11.176	1	13.636	2.414
LN-41	column	Metal	5.40E+04	2.80E+03	19.286	1	15.455	2.959
LN-54	case	Metal	5.80E+04	2.60E+03	22.308	1	17.273	3.105
LN-48	tool	Metal	4.90E+04	2.10E+03	23.333	1	19.091	3.150
LN-46	can	Metal	3.30E+04	1.40E+03	23.571	1	20.909	3.160
LN-6	bottle	Glass	9.30E+04	3.60E+03	25.833	1	22.727	3.252
LN-9	bulb	Glass	2.10E+04	7.90E+02	26.582	1	24.545	3.280
LN-19	bottle	Glass	4.20E+04	1.10E+03	38.182	1	26.364	3.642
LN-44	cap	Metal	2.40E+04	6.00E+02	40.000	2	30.000	3.689
LN-7	tool	Metal	6.00E+04	1.50E+03	40.000	0	30.000	3.689
LN-26	bottle	Glass	4.60E+04	1.00E+03	46.000	1	31.818	3.829
RH9P	Tool	Metal	8.20E+04	9.70E+02	84.536	1	33.636	4.437
RH9M	bottle	Glass	1.50E+05	1.60E+03	93.750	1	35.455	4.541
LN-4	bottle	Glass	2.00E+05	1.90E+03	105.263	1	37.273	4.656
RH9J	Lid	Poly	5.20E+04	4.70E+02	110.638	1	39.091	4.706
LN-49	socket	Metal	1.20E+05	7.80E+02	153.846	1	40.909	5.036
RH9H	Light Cord	Poly	1.00E+05	6.50E+02	153.846	1	42.727	5.036
RH9G	Valve	Poly	2.80E+04	1.80E+02	155.556	1	44.545	5.047
LN-35	bottle	Poly	1.40E+06	8.90E+03	157.303	1	46.364	5.058
RH9I	MSM Boot	Poly	9.40E+04	5.90E+02	159.322	1	48.182	5.071
RH9N	glassware	Glass	9.00E+05	5.40E+03	166.667	1	50.000	5.116
LN-8	bottle	Glass	3.80E+05	1.80E+03	211.111	1	51.818	5.352
LN-38	tool	Metal	5.30E+05	2.00E+03	265.000	1	53.636	5.580
LN-1	bottle	Glass	1.40E+06	4.50E+03	311.111	1	55.455	5.740
LN-15	tool	Metal	1.10E+06	3.40E+03	323.529	1	57.273	5.779
RH9E	Valve	Poly	9.70E+04	2.80E+02	346.429	1	59.091	5.848
LN-3	bottle	Glass	1.40E+06	3.80E+03	368.421	1	60.909	5.909
RH9L	bottle	Glass	3.40E+05	8.80E+02	386.364	1	62.727	5.957
RH9C	Melt	Poly	1.70E+05	4.00E+02	425.000	1	64.545	6.052
RH9EE	Valve	Poly	5.90E+05	1.30E+03	453.846	1	66.364	6.118
RH9Q	Wire	Metal	6.60E+05	1.40E+03	471.429	1	68.182	6.156
RH9S	Wipes	Wipes	2.30E+06	3.40E+03	676.471	1	70.000	6.517
RH9K	Lid	Poly	1.40E+06	1.80E+03	777.778	1	71.818	6.656
RH9F	Valve	Poly	2.00E+05	2.40E+02	833.333	1	73.636	6.725
LN-28	bottle	Glass	1.10E+06	1.30E+03	846.154	1	75.455	6.741
RH9QQ	Wire	Metal	2.00E+06	2.20E+03	909.091	1	77.273	6.812
RH9A	Melt	Poly	1.80E+05	1.40E+02	1285.714	1	79.091	7.159
RH9LL	bottle	Glass	1.10E+06	8.30E+02	1325.301	1	80.909	7.189
RH9D	bckt	Poly	1.30E+06	4.30E+02	3023.256	1	82.727	8.014
RH9KK	Lid	Poly	3.80E+05	1.10E+02	3454.545	1	84.545	8.147
RH9SS	Wipes	Wipes	2.80E+06	7.90E+02	3544.304	1	86.364	8.173
RH9R	Lid	Metal	1.60E+06	1.90E+02	8421.053	1	88.182	9.038
RH9V	Wipes	Wipes	9.40E+06	7.30E+02	12876.712	1	90.000	9.463
RH9O	housing	Glass	6.00E+05	3.70E+01	16216.216	1	91.818	9.694
RH9T	Wipes	Wipes	2.30E+06	6.80E+01	33823.529	1	93.636	10.429
RH9U	Wipes	Wipes	1.30E+07	1.20E+02	108333.333	1	95.455	11.593
LN-25	bottle	Glass	1.20E+08	6.80E+02	176470.588	1	97.273	12.081
RH9AA	Melt	Poly	6.90E+07	1.50E+02	460000.000	1	99.091	13.039

Pu238/Eu154

Sample ID	Waste Component	Waste Group	Pu238 (Bq/total)	Eu154 (Bq/total)	Pu238/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	3.80E+02	4.10E+04	0.009	1	0.909	-4.681
RH9H	Light Cord	Poly	2.90E+01	6.50E+02	0.045	1	2.727	-3.110
RH9I	MSM Boot	Poly	3.50E+01	5.90E+02	0.059	1	4.545	-2.825
RH9M	bottle	Glass	1.00E+02	1.60E+03	0.063	1	6.364	-2.773
LN-1	bottle	Glass	4.70E+02	4.50E+03	0.104	1	8.182	-2.259
RH9SS	Wipes	Wipes	1.10E+02	7.90E+02	0.139	1	10.000	-1.972
RH9LL	bottle	Glass	1.20E+02	8.30E+02	0.145	1	11.818	-1.934
LN-38	tool	Metal	6.90E+02	2.00E+03	0.345	1	13.636	-1.064
RH9N	glassware	Glass	1.95E+03	5.40E+03	0.361	1	15.455	-1.019
LN-3	bottle	Glass	1.40E+03	3.80E+03	0.368	1	17.273	-0.999
LN-33	valve	Poly	6.40E+03	1.70E+04	0.376	1	19.091	-0.977
RH9K	Lid	Poly	6.80E+02	1.80E+03	0.378	1	20.909	-0.973
LN-11	bottle	Glass	1.30E+03	3.40E+03	0.382	1	22.727	-0.961
LN-8	bottle	Glass	7.90E+02	1.80E+03	0.439	1	24.545	-0.824
RH9S	Wipes	Wipes	1.50E+03	3.40E+03	0.441	1	26.364	-0.818
LN-6	bottle	Glass	1.70E+03	3.60E+03	0.472	1	28.182	-0.750
RH9V	Wipes	Wipes	3.60E+02	7.30E+02	0.493	1	30.000	-0.707
LN-49	socket	Metal	4.00E+02	7.80E+02	0.513	1	31.818	-0.668
LN-4	bottle	Glass	9.80E+02	1.90E+03	0.516	1	33.636	-0.662
LN-54	case	Metal	1.40E+03	2.60E+03	0.538	1	35.455	-0.619
RH9L	bottle	Glass	5.00E+02	8.80E+02	0.568	1	37.273	-0.565
RH9J	Lid	Poly	2.70E+02	4.70E+02	0.574	1	39.091	-0.554
RH9Q	Wire	Metal	8.75E+02	1.40E+03	0.625	1	40.909	-0.470
LN-25	bottle	Glass	4.40E+02	6.80E+02	0.647	1	42.727	-0.435
LN-GL	bottles	Glass	2.70E+05	3.90E+05	0.692	1	44.545	-0.368
LN-41	column	Metal	2.00E+03	2.80E+03	0.714	1	46.364	-0.336
LN-48	tool	Metal	1.60E+03	2.10E+03	0.762	1	48.182	-0.272
LN-46	can	Metal	1.10E+03	1.40E+03	0.786	1	50.000	-0.241
LN-9	bulb	Glass	6.60E+02	7.90E+02	0.835	1	51.818	-0.180
LN-13	bottle	Glass	1.10E+03	1.30E+03	0.846	1	53.636	-0.167
RH9QQ	Wire	Metal	1.95E+03	2.20E+03	0.886	1	55.455	-0.121
RH9A	Melt	Poly	1.30E+02	1.40E+02	0.929	1	57.273	-0.074
LN-19	bottle	Glass	1.10E+03	1.10E+03	1.000	1	59.091	0.000
RH9P	Tool	Metal	9.90E+02	9.70E+02	1.021	1	60.909	0.020
RH9C	Melt	Poly	4.20E+02	4.00E+02	1.050	1	62.727	0.049
RH9E	Valve	Poly	3.00E+02	2.80E+02	1.071	1	64.545	0.069
LN-28	bottle	Glass	1.40E+03	1.30E+03	1.077	1	66.364	0.074
LN-26	bottle	Glass	1.10E+03	1.00E+03	1.100	1	68.182	0.095
RH9D	hckt	Poly	4.85E+02	4.30E+02	1.128	1	70.000	0.120
RH9AA	Melt	Poly	1.70E+02	1.50E+02	1.133	1	71.818	0.125
RH9R	Lid	Metal	2.40E+02	1.90E+02	1.263	1	73.636	0.234
RH9U	Wipes	Wipes	1.55E+02	1.20E+02	1.292	1	75.455	0.256
RH9O	housing	Glass	5.25E+01	3.70E+01	1.419	1	77.273	0.350
LN-36	cell	Metal	2.30E+03	1.60E+03	1.438	1	79.091	0.363
LN-35	bottle	Poly	1.40E+04	8.90E+03	1.573	1	80.909	0.453
LN-15	tool	Metal	6.30E+03	3.40E+03	1.853	1	82.727	0.617
LN-39	cell	Metal	3.00E+03	1.50E+03	2.000	1	84.545	0.693
LN-ML	tool	Metal	1.10E+06	5.20E+05	2.115	1	86.364	0.749
LN-7	tool	Metal	3.40E+03	1.50E+03	2.267	1	88.182	0.818
RH9F	Valve	Poly	1.00E+03	2.40E+02	4.167	1	90.000	1.427
RH9G	Valve	Poly	8.00E+02	1.80E+02	4.444	1	91.818	1.492
RH9EE	Valve	Poly	6.20E+03	1.30E+03	4.769	1	93.636	1.562
LN-44	cap	Metal	3.10E+03	6.00E+02	5.167	1	95.455	1.642
RH9T	Wipes	Wipes	3.90E+02	6.80E+01	5.735	1	97.273	1.747
RH9KK	Lid	Poly	8.50E+02	1.10E+02	7.727	1	99.091	2.045

Pu*/Eu154

Sample ID	Waste Component	Waste Group	Pu* (Bq/total)	Eu154 (Bq/total)	Pu*/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-ML	tool	Wipes	1.55E+02	5.20E+05	0.000	1	0.909	-8.118
LN-40	hose	Glass	4.60E+02	4.10E+04	0.011	1	2.727	-4.490
LN-33	valve	Poly	4.85E+02	1.70E+04	0.029	1	4.545	-3.557
LN-3	bottle	Wipes	1.20E+02	3.80E+03	0.032	1	6.364	-3.455
LN-39	cell	Poly	5.80E+01	1.50E+03	0.039	1	8.182	-3.253
RH9N	glassware	Poly	2.60E+02	5.40E+03	0.048	1	10.000	-3.033
LN-35	bottle	Poly	5.20E+02	8.90E+03	0.058	1	11.818	-2.840
LN-1	bottle	Poly	2.90E+02	4.50E+03	0.064	1	13.636	-2.742
RH9S	Wipes	Wipes	2.90E+02	3.40E+03	0.085	1	15.455	-2.462
LN-13	bottle	Glass	1.20E+02	1.30E+03	0.092	1	17.273	-2.383
LN-46	can	Wipes	1.50E+02	1.40E+03	0.107	1	19.091	-2.234
LN-48	tool	Poly	2.50E+02	2.10E+03	0.119	1	20.909	-2.128
LN-9	bulb	Poly	1.10E+02	7.90E+02	0.139	1	22.727	-1.972
LN-41	column	Metal	4.00E+02	2.80E+03	0.143	1	24.545	-1.946
LN-11	bottle	Glass	5.10E+02	3.40E+03	0.150	1	26.364	-1.897
LN-6	bottle	Metal	5.70E+02	3.60E+03	0.158	1	28.182	-1.843
LN-8	bottle	Wipes	3.50E+02	1.80E+03	0.194	1	30.000	-1.638
LN-54	case	Poly	6.20E+02	2.60E+03	0.238	1	31.818	-1.434
RH9EE	Valve	Metal	4.00E+02	1.30E+03	0.308	1	33.636	-1.179
RH9H	Light Cord	Poly	2.60E+02	6.50E+02	0.400	1	35.455	-0.916
LN-38	tool	Metal	9.30E+02	2.00E+03	0.465	1	37.273	-0.766
LN-26	bottle	Metal	4.80E+02	1.00E+03	0.480	1	39.091	-0.734
LN-49	socket	Glass	4.00E+02	7.80E+02	0.513	1	40.909	-0.668
LN-28	bottle	Metal	6.80E+02	1.30E+03	0.523	1	42.727	-0.648
RH9A	Melt	Poly	9.10E+01	1.40E+02	0.650	1	44.545	-0.431
LN-GL	bottles	Metal	2.90E+05	3.90E+05	0.744	1	46.364	-0.296
RH9C	Melt	Glass	3.00E+02	4.00E+02	0.750	1	48.182	-0.288
RH9I	MSM Boot	Poly	5.15E+02	5.90E+02	0.873	1	50.000	-0.136
RH9D	bckt	Poly	4.40E+02	4.30E+02	1.023	1	51.818	0.023
LN-36	cell	Metal	2.10E+03	1.60E+03	1.313	1	53.636	0.272
RH9L	bottle	Metal	1.40E+03	8.80E+02	1.591	1	55.455	0.464
LN-19	bottle	Glass	2.00E+03	1.10E+03	1.818	1	57.273	0.598
LN-44	cap	Metal	1.10E+03	6.00E+02	1.833	1	59.091	0.606
RH9G	Valve	Poly	3.50E+02	1.80E+02	1.944	1	60.909	0.665
RH9KK	Lid	Metal	2.15E+02	1.10E+02	1.955	1	62.727	0.670
RH9F	Valve	Poly	5.00E+02	2.40E+02	2.083	1	64.545	0.734
RH9LL	bottle	Metal	1.80E+03	8.30E+02	2.169	1	66.364	0.774
RH9J	Lid	Glass	1.10E+03	4.70E+02	2.340	1	68.182	0.850
LN-7	tool	Glass	4.00E+03	1.50E+03	2.667	1	70.000	0.981
RH9QQ	Wire	Glass	6.30E+03	2.20E+03	2.864	1	71.818	1.052
RH9K	Lid	Poly	5.50E+03	1.80E+03	3.056	1	73.636	1.117
RH9M	bottle	Glass	4.90E+03	1.60E+03	3.063	1	75.455	1.119
RH9E	Valve	Metal	9.50E+02	2.80E+02	3.393	1	77.273	1.222
LN-4	bottle	Glass	6.90E+03	1.90E+03	3.632	1	79.091	1.290
RH9Q	Wire	Metal	6.20E+03	1.40E+03	4.429	1	80.909	1.488
RH9SS	Wipes	Metal	3.80E+03	7.90E+02	4.810	1	82.727	1.571
RH9P	Tool	Glass	4.70E+03	9.70E+02	4.845	1	84.545	1.578
LN-25	bottle	Poly	3.60E+03	6.80E+02	5.294	1	86.364	1.667
RH9U	Wipes	Metal	8.75E+02	1.20E+02	7.292	1	88.182	1.987
RH9AA	Melt	Glass	1.10E+03	1.50E+02	7.333	1	90.000	1.992
RH9V	Wipes	Glass	8.90E+03	7.30E+02	12.192	1	91.818	2.501
RH9R	Lid	Glass	6.60E+03	1.90E+02	34.737	1	93.636	3.548
RH9T	Wipes	Glass	6.30E+03	6.80E+01	92.647	1	95.455	4.529
LN-15	tool	Glass	3.20E+05	3.40E+03	94.118	1	97.273	4.545
RH9O	housing	Glass	4.00E+03	3.70E+01	108.108	1	99.091	4.683

Pu242/Eu154

Sample ID	Waste Component	Waste Group	Pu242 (Bq/total)	Eu154 (Bq/total)	Pu242/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	8.70E+00	4.10E+04	0.000	1	0.909	-8.458
LN-33	valve	Poly	5.00E+01	1.70E+04	0.003	1	2.727	-5.829
LN-3	bottle	Glass	1.50E+01	3.80E+03	0.004	3	8.182	-5.535
LN-1	bottle	Glass	2.00E+01	4.50E+03	0.004	0	8.182	-5.416
LN-6	bottle	Glass	1.60E+01	3.60E+03	0.004	0	8.182	-5.416
LN-11	bottle	Glass	2.00E+01	3.40E+03	0.006	3	13.636	-5.136
LN-48	tool	Metal	1.30E+01	2.10E+03	0.006	0	13.636	-5.085
LN-39	cell	Metal	9.30E+00	1.50E+03	0.006	0	13.636	-5.083
LN-4	bottle	Glass	2.00E+01	1.90E+03	0.011	2	17.273	-4.554
LN-GL	bottles	Glass	4.20E+03	3.90E+05	0.011	0	17.273	-4.531
LN-25	bottle	Glass	8.00E+00	6.80E+02	0.012	3	22.727	-4.443
LN-41	column	Metal	3.30E+01	2.80E+03	0.012	0	22.727	-4.441
LN-46	can	Metal	1.70E+01	1.40E+03	0.012	0	22.727	-4.411
LN-54	case	Metal	3.40E+01	2.60E+03	0.013	1	24.545	-4.337
LN-38	tool	Metal	2.80E+01	2.00E+03	0.014	1	26.364	-4.269
LN-36	cell	Metal	2.40E+01	1.60E+03	0.015	2	30.000	-4.200
LN-13	bottle	Glass	2.00E+01	1.30E+03	0.015	0	30.000	-4.174
LN-15	tool	Metal	6.60E+01	3.40E+03	0.019	1	31.818	-3.942
LN-35	bottle	Poly	2.00E+02	8.90E+03	0.022	1	33.636	-3.795
LN-8	bottle	Glass	4.40E+01	1.80E+03	0.024	1	35.455	-3.711
LN-ML	tool	Metal	1.30E+04	5.20E+05	0.025	1	37.273	-3.689
LN-19	bottle	Glass	3.20E+01	1.10E+03	0.029	1	39.091	-3.537
LN-7	tool	Metal	4.80E+01	1.50E+03	0.032	1	40.909	-3.442
LN-28	bottle	Glass	4.90E+01	1.30E+03	0.038	1	42.727	-3.278
LN-9	bulb	Glass	3.90E+01	7.90E+02	0.049	1	44.545	-3.008
LN-26	bottle	Glass	6.50E+01	1.00E+03	0.065	1	46.364	-2.733
LN-44	cap	Metal	4.60E+01	6.00E+02	0.077	1	48.182	-2.568
LN-49	socket	Metal	8.20E+01	7.80E+02	0.105	1	50.000	-2.253
RH9LL	bottle	Glass	1.20E+02	8.30E+02	0.145	1	51.818	-1.934
RH9N	glassware	Glass	1.95E+03	5.40E+03	0.361	1	53.636	-1.019
RH9S	Wipes	Wipes	1.50E+03	3.40E+03	0.441	1	55.455	-0.818
RH9AA	Melt	Poly	9.10E+01	1.50E+02	0.607	1	57.273	-0.500
RH9K	Lid	Poly	1.10E+03	1.80E+03	0.611	1	59.091	-0.492
RH9M	bottle	Glass	1.00E+03	1.60E+03	0.625	2	62.727	-0.470
RH9Q	Wire	Metal	8.75E+02	1.40E+03	0.625	0	62.727	-0.470
RH9L	bottle	Glass	6.00E+02	8.80E+02	0.682	1	64.545	-0.383
RH9SS	Wipes	Wipes	6.10E+02	7.90E+02	0.772	1	66.364	-0.259
RH9A	Melt	Poly	1.10E+02	1.40E+02	0.786	1	68.182	-0.241
RH9H	Light Cord	Poly	5.15E+02	6.50E+02	0.792	1	70.000	-0.233
RH9V	Wipes	Wipes	5.85E+02	7.30E+02	0.801	1	71.818	-0.221
RH9C	Melt	Poly	3.50E+02	4.00E+02	0.875	1	73.636	-0.134
RH9QQ	Wire	Metal	1.95E+03	2.20E+03	0.886	1	75.455	-0.121
RH9E	Valve	Poly	2.60E+02	2.80E+02	0.929	1	77.273	-0.074
RH9P	Tool	Metal	9.90E+02	9.70E+02	1.021	1	79.091	0.020
RH9I	MSM Boot	Poly	6.35E+02	5.90E+02	1.076	1	80.909	0.074
RH9J	Lid	Poly	5.20E+02	4.70E+02	1.106	1	82.727	0.101
RH9D	hckt	Poly	4.85E+02	4.30E+02	1.128	1	84.545	0.120
RH9R	Lid	Metal	2.15E+02	1.90E+02	1.132	1	86.364	0.124
RH9U	Wipes	Wipes	1.55E+02	1.20E+02	1.292	1	88.182	0.256
RH9O	housing	Glass	5.25E+01	3.70E+01	1.419	1	90.000	0.350
RH9G	Valve	Poly	2.90E+02	1.80E+02	1.611	1	91.818	0.477
RH9T	Wipes	Wipes	1.65E+02	6.80E+01	2.426	1	93.636	0.886
RH9F	Valve	Poly	1.00E+03	2.40E+02	4.167	1	95.455	1.427
RH9EE	Valve	Poly	6.20E+03	1.30E+03	4.769	1	97.273	1.562
RH9KK	Lid	Poly	5.75E+02	1.10E+02	5.227	1	99.091	1.654

Am241/Eu154

Sample ID	Waste Component	Waste Group	Am241 (Bq/total)	Eu154 (Bq/total)	Am241/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	1.10E+04	4.10E+04	0.268	1	0.909	-1.316
RH9S	Wipes	Wipes	2.10E+03	3.40E+03	0.618	1	2.727	-0.482
LN-3	bottle	Glass	2.50E+03	3.80E+03	0.658	1	4.545	-0.419
RH9K	Lid	Poly	1.30E+03	1.80E+03	0.722	1	6.364	-0.325
RH9SS	Wipes	Wipes	6.20E+02	7.90E+02	0.785	1	8.182	-0.242
LN-38	tool	Metal	1.70E+03	2.00E+03	0.850	1	10.000	-0.163
RH9M	bottle	Glass	1.40E+03	1.60E+03	0.875	1	11.818	-0.134
LN-33	valve	Poly	1.50E+04	1.70E+04	0.882	1	13.636	-0.125
RH9G	Valve	Poly	1.60E+02	1.80E+02	0.889	1	15.455	-0.118
RH9L	bottle	Glass	8.20E+02	8.80E+02	0.932	1	17.273	-0.071
RH9LL	bottle	Glass	8.50E+02	8.30E+02	1.024	1	19.091	0.024
RH9V	Wipes	Wipes	7.60E+02	7.30E+02	1.041	1	20.909	0.040
RH9AA	Melt	Poly	1.70E+02	1.50E+02	1.133	1	22.727	0.125
LN-49	socket	Metal	8.90E+02	7.80E+02	1.141	1	24.545	0.132
LN-4	bottle	Glass	2.20E+03	1.90E+03	1.158	1	26.364	0.147
RH9R	Lid	Metal	2.20E+02	1.90E+02	1.158	1	28.182	0.147
RH9E	Valve	Poly	3.50E+02	2.80E+02	1.250	1	30.000	0.223
RH9T	Wipes	Wipes	8.70E+01	6.80E+01	1.279	1	31.818	0.246
LN-46	can	Metal	2.00E+03	1.40E+03	1.429	1	33.636	0.357
RH9H	Light Cord	Poly	9.40E+02	6.50E+02	1.446	1	35.455	0.369
RH9O	housing	Glass	5.40E+01	3.70E+01	1.459	1	37.273	0.378
RH9J	Lid	Poly	7.20E+02	4.70E+02	1.532	1	39.091	0.427
RH9I	MSM Boot	Poly	9.10E+02	5.90E+02	1.542	1	40.909	0.433
RH9A	Melt	Poly	2.20E+02	1.40E+02	1.571	1	42.727	0.452
LN-GL	bottles	Glass	6.20E+05	3.90E+05	1.590	1	44.545	0.464
LN-1	bottle	Glass	7.30E+03	4.50E+03	1.622	1	46.364	0.484
LN-7	tool	Metal	2.50E+03	1.50E+03	1.667	1	48.182	0.511
LN-28	bottle	Glass	2.20E+03	1.30E+03	1.692	1	50.000	0.526
LN-26	bottle	Glass	1.70E+03	1.00E+03	1.700	1	51.818	0.531
LN-19	bottle	Glass	1.90E+03	1.10E+03	1.727	1	53.636	0.547
LN-15	tool	Metal	5.90E+03	3.40E+03	1.735	1	55.455	0.551
LN-48	tool	Metal	3.70E+03	2.10E+03	1.762	1	57.273	0.566
LN-8	bottle	Glass	3.20E+03	1.80E+03	1.778	1	59.091	0.575
LN-ML	tool	Metal	9.30E+05	5.20E+05	1.788	1	60.909	0.581
LN-11	bottle	Glass	6.20E+03	3.40E+03	1.824	1	62.727	0.601
RH9C	Melt	Poly	7.40E+02	4.00E+02	1.850	1	64.545	0.615
LN-9	bulb	Glass	1.50E+03	7.90E+02	1.899	1	66.364	0.641
RH9F	Valve	Poly	4.60E+02	2.40E+02	1.917	1	68.182	0.651
LN-6	bottle	Glass	7.10E+03	3.60E+03	1.972	1	70.000	0.679
LN-54	case	Metal	5.20E+03	2.60E+03	2.000	1	71.818	0.693
RH9N	glassware	Glass	1.10E+04	5.40E+03	2.037	1	73.636	0.711
RH9Q	Wire	Metal	3.00E+03	1.40E+03	2.143	1	75.455	0.762
LN-13	bottle	Glass	2.80E+03	1.30E+03	2.154	2	79.091	0.767
RH9EE	Valve	Poly	2.80E+03	1.30E+03	2.154	0	79.091	0.767
RH9P	Tool	Metal	2.20E+03	9.70E+02	2.268	1	80.909	0.819
RH9KK	Lid	Poly	2.50E+02	1.10E+02	2.273	1	82.727	0.821
RH9D	bckt	Poly	1.00E+03	4.30E+02	2.326	1	84.545	0.844
RH9QQ	Wire	Metal	5.60E+03	2.20E+03	2.545	1	86.364	0.934
LN-41	column	Metal	7.20E+03	2.80E+03	2.571	1	88.182	0.944
RH9U	Wipes	Wipes	3.20E+02	1.20E+02	2.667	1	90.000	0.981
LN-44	cap	Metal	2.20E+03	6.00E+02	3.667	1	91.818	1.299
LN-35	bottle	Poly	5.80E+04	8.90E+03	6.517	1	93.636	1.874
LN-25	bottle	Glass	4.90E+03	6.80E+02	7.206	1	95.455	1.975
LN-36	cell	Metal	8.30E+04	1.60E+03	51.875	1	97.273	3.949
LN-39	cell	Metal	1.10E+05	1.50E+03	73.333	1	99.091	4.295

Am243/Eu154

Sample ID	Waste Component	Waste Group	Am243 (Bq/total)	Eu154 (Bq/total)	Am243/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9N	glassware	Glass	1.00E+02	5.40E+03	0.019	1	0.909	-3.989
RH9Q	Wire	Metal	4.30E+01	1.40E+03	0.031	1	2.727	-3.483
RH9A	Melt	Poly	5.10E+00	1.40E+02	0.036	1	4.545	-3.312
RH9L	bottle	Glass	3.40E+01	8.80E+02	0.039	1	6.364	-3.254
LN-35	bottle	Poly	3.70E+02	8.90E+03	0.042	1	8.182	-3.180
RH9K	Lid	Poly	8.10E+01	1.80E+03	0.045	1	10.000	-3.101
RH9SS	Wipes	Wipes	3.60E+01	7.90E+02	0.046	1	11.818	-3.089
RH9G	Valve	Poly	8.90E+00	1.80E+02	0.049	1	13.636	-3.007
RH9LL	bottle	Glass	4.20E+01	8.30E+02	0.051	1	15.455	-2.984
RH9C	Melt	Poly	2.10E+01	4.00E+02	0.053	3	20.909	-2.947
RH9R	Lid	Metal	1.00E+01	1.90E+02	0.053	0	20.909	-2.944
LN-7	tool	Metal	8.00E+01	1.50E+03	0.053	0	20.909	-2.931
RH9QQ	Wire	Metal	1.20E+02	2.20E+03	0.055	1	22.727	-2.909
RH9M	bottle	Glass	8.90E+01	1.60E+03	0.056	1	24.545	-2.889
RH9J	Lid	Poly	2.90E+01	4.70E+02	0.062	1	26.364	-2.785
RH9D	bckt	Poly	2.80E+01	4.30E+02	0.065	1	28.182	-2.732
RH9U	Wipes	Wipes	8.00E+00	1.20E+02	0.067	1	30.000	-2.708
RH9H	Light Cord	Poly	4.60E+01	6.50E+02	0.071	3	35.455	-2.648
RH9I	MSM Boot	Poly	4.20E+01	5.90E+02	0.071	0	35.455	-2.642
LN-48	tool	Metal	1.50E+02	2.10E+03	0.071	0	35.455	-2.639
RH9AA	Melt	Poly	1.10E+01	1.50E+02	0.073	1	37.273	-2.613
LN-41	column	Metal	2.10E+02	2.80E+03	0.075	1	39.091	-2.590
LN-33	valve	Poly	1.30E+03	1.70E+04	0.076	1	40.909	-2.571
LN-46	can	Metal	1.10E+02	1.40E+03	0.079	1	42.727	-2.544
LN-38	tool	Metal	1.70E+02	2.00E+03	0.085	2	46.364	-2.465
LN-15	tool	Metal	2.90E+02	3.40E+03	0.085	0	46.364	-2.462
RH9S	Wipes	Wipes	3.20E+02	3.40E+03	0.094	2	50.000	-2.363
LN-ML	tool	Metal	4.90E+04	5.20E+05	0.094	0	50.000	-2.362
RH9V	Wipes	Wipes	6.90E+01	7.30E+02	0.095	1	51.818	-2.359
RH9P	Tool	Metal	9.60E+01	9.70E+02	0.099	1	53.636	-2.313
LN-1	bottle	Glass	4.50E+02	4.50E+03	0.100	3	59.091	-2.303
RH9F	Valve	Poly	2.40E+01	2.40E+02	0.100	0	59.091	-2.303
RH9KK	Lid	Poly	1.10E+01	1.10E+02	0.100	0	59.091	-2.303
RH9O	housing	Glass	4.00E+00	3.70E+01	0.108	1	60.909	-2.225
RH9T	Wipes	Wipes	7.50E+00	6.80E+01	0.110	1	62.727	-2.205
LN-49	socket	Metal	8.80E+01	7.80E+02	0.113	1	64.545	-2.182
RH9E	Valve	Poly	3.20E+01	2.80E+02	0.114	1	66.364	-2.169
LN-11	bottle	Glass	4.10E+02	3.40E+03	0.121	1	68.182	-2.115
LN-54	case	Metal	3.20E+02	2.60E+03	0.123	1	70.000	-2.095
LN-19	bottle	Glass	1.40E+02	1.10E+03	0.127	1	71.818	-2.061
LN-40	hose	Poly	5.80E+03	4.10E+04	0.141	1	73.636	-1.956
LN-3	bottle	Glass	5.70E+02	3.80E+03	0.150	1	75.455	-1.897
RH9EE	Valve	Poly	2.10E+02	1.30E+03	0.162	1	77.273	-1.823
LN-GL	bottles	Glass	7.10E+04	3.90E+05	0.182	1	79.091	-1.703
LN-6	bottle	Glass	6.80E+02	3.60E+03	0.189	1	80.909	-1.667
LN-8	bottle	Glass	3.70E+02	1.80E+03	0.206	1	82.727	-1.582
LN-4	bottle	Glass	4.10E+02	1.90E+03	0.216	1	84.545	-1.533
LN-28	bottle	Glass	2.90E+02	1.30E+03	0.223	1	86.364	-1.500
LN-13	bottle	Glass	3.00E+02	1.30E+03	0.231	1	88.182	-1.466
LN-26	bottle	Glass	2.40E+02	1.00E+03	0.240	1	90.000	-1.427
LN-44	cap	Metal	1.90E+02	6.00E+02	0.317	1	91.818	-1.150
LN-25	bottle	Glass	2.20E+02	6.80E+02	0.324	1	93.636	-1.128
LN-9	bulb	Glass	3.10E+02	7.90E+02	0.392	1	95.455	-0.935
LN-36	cell	Metal	1.00E+03	1.60E+03	0.625	1	97.273	-0.470
LN-39	cell	Metal	1.20E+03	1.50E+03	0.800	1	99.091	-0.223

Cf252/Eu154

Sample ID	Waste Component	Waste Group	Cf252 (Bq/total)	Eu154 (Bq/total)	Cf252/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9S	Wipes	Wipes	3.90E+02	3.40E+03	0.115	1	0.909	-2.165
RH9LL	bottle	Glass	1.80E+02	8.30E+02	0.217	1	2.727	-1.528
LN-40	hose	Poly	1.80E+04	4.10E+04	0.439	1	4.545	-0.823
RH9N	glassware	Glass	2.90E+03	5.40E+03	0.537	1	6.364	-0.622
RH9Q	Wire	Metal	8.40E+02	1.40E+03	0.600	1	8.182	-0.511
LN-3	bottle	Glass	2.60E+03	3.80E+03	0.684	1	10.000	-0.379
LN-33	valve	Poly	1.30E+04	1.70E+04	0.765	1	11.818	-0.268
RH9G	Valve	Poly	1.50E+02	1.80E+02	0.833	1	13.636	-0.182
LN-6	bottle	Glass	3.20E+03	3.60E+03	0.889	1	15.455	-0.118
LN-38	tool	Metal	1.90E+03	2.00E+03	0.950	1	17.273	-0.051
LN-54	case	Metal	2.50E+03	2.60E+03	0.962	1	19.091	-0.039
LN-49	socket	Metal	7.80E+02	7.80E+02	1.000	1	20.909	0.000
RH9H	Light Cord	Poly	7.00E+02	6.50E+02	1.077	1	22.727	0.074
LN-48	tool	Metal	2.50E+03	2.10E+03	1.190	1	24.545	0.174
RH9P	Tool	Metal	1.20E+03	9.70E+02	1.237	1	26.364	0.213
LN-46	can	Metal	1.80E+03	1.40E+03	1.286	1	28.182	0.251
LN-4	bottle	Glass	2.50E+03	1.90E+03	1.316	1	30.000	0.274
RH9SS	Wipes	Wipes	1.20E+03	7.90E+02	1.519	1	31.818	0.418
RH9AA	Melt	Poly	2.30E+02	1.50E+02	1.533	1	33.636	0.427
RH9QQ	Wire	Metal	3.40E+03	2.20E+03	1.545	1	35.455	0.435
LN-8	bottle	Glass	2.80E+03	1.80E+03	1.556	1	37.273	0.442
RH9I	MSM Boot	Poly	9.40E+02	5.90E+02	1.593	1	39.091	0.466
LN-28	bottle	Glass	2.10E+03	1.30E+03	1.615	1	40.909	0.480
LN-11	bottle	Glass	5.50E+03	3.40E+03	1.618	2	44.545	0.481
LN-25	bottle	Glass	1.10E+03	6.80E+02	1.618	0	44.545	0.481
RH9C	Melt	Poly	6.60E+02	4.00E+02	1.650	1	46.364	0.501
RH9K	Lid	Poly	3.10E+03	1.80E+03	1.722	1	48.182	0.544
LN-19	bottle	Glass	2.10E+03	1.10E+03	1.909	1	50.000	0.647
LN-13	bottle	Glass	2.50E+03	1.30E+03	1.923	1	51.818	0.654
LN-44	cap	Metal	1.20E+03	6.00E+02	2.000	3	57.273	0.693
RH9A	Melt	Poly	2.80E+02	1.40E+02	2.000	0	57.273	0.693
RH9M	bottle	Glass	3.20E+03	1.60E+03	2.000	0	57.273	0.693
LN-9	bulb	Glass	1.60E+03	7.90E+02	2.025	1	59.091	0.706
RH9D	bckt	Poly	8.80E+02	4.30E+02	2.047	1	60.909	0.716
RH9R	Lid	Metal	3.90E+02	1.90E+02	2.053	1	62.727	0.719
LN-41	column	Metal	6.00E+03	2.80E+03	2.143	1	64.545	0.762
RH9L	bottle	Glass	1.90E+03	8.80E+02	2.159	1	66.364	0.770
LN-35	bottle	Poly	2.10E+04	8.90E+03	2.360	1	68.182	0.858
RH9EE	Valve	Poly	3.10E+03	1.30E+03	2.385	1	70.000	0.869
RH9E	Valve	Poly	7.20E+02	2.80E+02	2.571	1	71.818	0.944
RH9U	Wipes	Wipes	3.20E+02	1.20E+02	2.667	1	73.636	0.981
LN-36	cell	Metal	4.50E+03	1.60E+03	2.813	1	75.455	1.034
RH9V	Wipes	Wipes	2.10E+03	7.30E+02	2.877	1	77.273	1.057
LN-15	tool	Metal	1.00E+04	3.40E+03	2.941	2	80.909	1.079
RH9T	Wipes	Wipes	2.00E+02	6.80E+01	2.941	0	80.909	1.079
LN-7	tool	Metal	4.80E+03	1.50E+03	3.200	1	82.727	1.163
LN-GL	bottles	Glass	1.30E+06	3.90E+05	3.333	1	84.545	1.204
RH9F	Valve	Poly	8.10E+02	2.40E+02	3.375	1	86.364	1.216
LN-39	cell	Metal	5.20E+03	1.50E+03	3.467	1	88.182	1.243
LN-1	bottle	Glass	1.60E+04	4.50E+03	3.556	1	90.000	1.269
LN-ML	tool	Metal	2.00E+06	5.20E+05	3.846	1	91.818	1.347
LN-26	bottle	Glass	5.80E+03	1.00E+03	5.800	1	93.636	1.758
RH9J	Lid	Poly	7.10E+03	4.70E+02	15.106	1	95.455	2.715
RH9KK	Lid	Poly	2.70E+03	1.10E+02	24.545	1	97.273	3.201
RH9O	housing	Glass	1.40E+03	3.70E+01	37.838	1	99.091	3.633

Cm242/Eu154

Sample ID	Waste Component	Waste Group	Cm242 (Bq/total)	Eu154 (Bq/total)	Cm242/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-ML	Wipes	Wipes	7.30E+02	5.20E+05	0.001	1	0.909	-6.569
LN-GL	bottle	Glass	3.10E+03	3.90E+05	0.008	1	2.727	-4.835
LN-11	bottle	Glass	1.20E+02	3.40E+03	0.035	1	4.545	-3.344
LN-40	tool	Metal	1.50E+03	4.10E+04	0.037	1	6.364	-3.308
LN-13	housing	Glass	5.30E+01	1.30E+03	0.041	1	8.182	-3.200
LN-35	bottle	Glass	6.10E+02	8.90E+03	0.069	1	10.000	-2.680
LN-41	Wipes	Wipes	2.10E+02	2.80E+03	0.075	1	11.818	-2.590
LN-7	Melt	Poly	1.70E+02	1.50E+03	0.113	1	13.636	-2.177
LN-46	Valve	Poly	1.70E+02	1.40E+03	0.121	1	15.455	-2.108
LN-49	Valve	Poly	1.10E+02	7.80E+02	0.141	1	17.273	-1.959
RH9EE	Melt	Poly	1.90E+02	1.30E+03	0.146	1	19.091	-1.923
LN-54	Light Cord	Poly	4.30E+02	2.60E+03	0.165	1	20.909	-1.799
LN-28	socket	Metal	3.00E+02	1.30E+03	0.231	1	22.727	-1.466
LN-19	can	Metal	3.20E+02	1.10E+03	0.291	1	24.545	-1.235
LN-38	bckt	Poly	8.00E+02	2.00E+03	0.400	1	26.364	-0.916
RH9K	Tool	Metal	8.00E+02	1.80E+03	0.444	1	28.182	-0.811
LN-33	valve	Poly	9.40E+03	1.70E+04	0.553	1	30.000	-0.593
LN-4	bottle	Glass	1.20E+03	1.90E+03	0.632	1	31.818	-0.460
RH9J	Lid	Metal	3.40E+02	4.70E+02	0.723	1	33.636	-0.324
LN-9	Valve	Poly	5.90E+02	7.90E+02	0.747	1	35.455	-0.292
RH9N	cell	Metal	5.00E+03	5.40E+03	0.926	1	37.273	-0.077
LN-39	tool	Metal	1.40E+03	1.50E+03	0.933	1	39.091	-0.069
RH9A	Wipes	Wipes	1.50E+02	1.40E+02	1.071	1	40.909	0.069
LN-48	case	Metal	2.30E+03	2.10E+03	1.095	1	42.727	0.091
LN-8	Lid	Poly	2.20E+03	1.80E+03	1.222	1	44.545	0.201
LN-3	bottle	Glass	5.80E+03	3.80E+03	1.526	1	46.364	0.423
RH9S	tool	Metal	5.70E+03	3.40E+03	1.676	1	48.182	0.517
LN-36	bottle	Glass	2.70E+03	1.60E+03	1.688	1	50.000	0.523
LN-26	column	Metal	1.70E+03	1.00E+03	1.700	1	51.818	0.531
RH9E	Melt	Poly	5.30E+02	2.80E+02	1.893	1	53.636	0.638
RH9C	MSM Boot	Poly	7.60E+02	4.00E+02	1.900	1	55.455	0.642
RH9AA	Wipes	Wipes	2.90E+02	1.50E+02	1.933	1	57.273	0.659
RH9D	Wipes	Wipes	9.50E+02	4.30E+02	2.209	1	59.091	0.793
RH9Q	tool	Metal	3.80E+03	1.40E+03	2.714	1	60.909	0.999
RH9L	glassware	Glass	2.40E+03	8.80E+02	2.727	1	62.727	1.003
LN-1	hose	Poly	1.30E+04	4.50E+03	2.889	1	64.545	1.061
RH9SS	Lid	Poly	2.40E+03	7.90E+02	3.038	1	66.364	1.111
RH9I	bottle	Glass	2.10E+03	5.90E+02	3.559	1	68.182	1.270
RH9P	Wire	Metal	4.00E+03	9.70E+02	4.124	1	70.000	1.417
RH9M	cell	Metal	7.80E+03	1.60E+03	4.875	1	71.818	1.584
RH9H	bottle	Glass	3.60E+03	6.50E+02	5.538	1	73.636	1.712
RH9LL	bulb	Glass	6.40E+03	8.30E+02	7.711	1	75.455	2.043
RH9QQ	bottle	Poly	1.90E+04	2.20E+03	8.636	1	77.273	2.156
RH9F	bottle	Glass	2.30E+03	2.40E+02	9.583	1	79.091	2.260
LN-25	bottle	Glass	8.80E+03	6.80E+02	12.941	1	80.909	2.560
RH9KK	bottle	Glass	2.00E+03	1.10E+02	18.182	1	82.727	2.900
RH9U	Lid	Poly	2.20E+03	1.20E+02	18.333	1	84.545	2.909
RH9G	bottle	Glass	3.70E+03	1.80E+02	20.556	1	86.364	3.023
RH9R	cap	Metal	4.10E+03	1.90E+02	21.579	1	88.182	3.072
RH9V	Valve	Poly	1.60E+04	7.30E+02	21.918	1	90.000	3.087
RH9T	Wire	Metal	1.60E+03	6.80E+01	23.529	1	91.818	3.158
LN-44	bottle	Glass	1.60E+04	6.00E+02	26.667	1	93.636	3.283
RH9O	bottle	Glass	1.30E+03	3.70E+01	35.135	1	95.455	3.559
LN-6	tool	Metal	4.10E+05	3.60E+03	113.889	1	97.273	4.735
LN-15	bottles	Glass	5.00E+05	3.40E+03	147.059	1	99.091	4.991

Cm246/Eu154

Sample ID	Waste Component	Waste Group	Cm246 (Bq/total)	Eu154 (Bq/total)	Cm246/Eu154 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9LL	bottle	Glass	1.20E+02	8.30E+02	0.145	1	0.909	-1.934
RH9K	Lid	Poly	3.30E+02	1.80E+03	0.183	1	2.727	-1.696
RH9V	Wipes	Wipes	1.80E+02	7.30E+02	0.247	1	4.545	-1.400
LN-46	can	Metal	3.80E+02	1.40E+03	0.271	1	6.364	-1.304
LN-40	hose	Poly	1.45E+04	4.10E+04	0.354	1	8.182	-1.039
RH9N	glassware	Glass	1.95E+03	5.40E+03	0.361	1	10.000	-1.019
LN-38	tool	Metal	8.40E+02	2.00E+03	0.420	1	11.818	-0.868
RH9S	Wipes	Wipes	1.50E+03	3.40E+03	0.441	1	13.636	-0.818
RH9EE	Valve	Poly	6.20E+02	1.30E+03	0.477	1	15.455	-0.740
RH9AA	Melt	Poly	9.10E+01	1.50E+02	0.607	1	17.273	-0.500
RH9M	bottle	Glass	1.00E+03	1.60E+03	0.625	2	20.909	-0.470
RH9Q	Wire	Metal	8.75E+02	1.40E+03	0.625	0	20.909	-0.470
RH9L	bottle	Glass	6.00E+02	8.80E+02	0.682	1	22.727	-0.383
LN-54	case	Metal	1.80E+03	2.60E+03	0.692	1	24.545	-0.368
RH9SS	Wipes	Wipes	6.10E+02	7.90E+02	0.772	1	26.364	-0.259
RH9A	Melt	Poly	1.10E+02	1.40E+02	0.786	1	28.182	-0.241
RH9H	Light Cord	Poly	5.15E+02	6.50E+02	0.792	1	30.000	-0.233
LN-33	valve	Poly	1.40E+04	1.70E+04	0.824	1	31.818	-0.194
RH9C	Melt	Poly	3.50E+02	4.00E+02	0.875	1	33.636	-0.134
RH9QQ	Wire	Metal	1.95E+03	2.20E+03	0.886	1	35.455	-0.121
RH9E	Valve	Poly	2.60E+02	2.80E+02	0.929	1	37.273	-0.074
LN-15	tool	Metal	3.30E+03	3.40E+03	0.971	1	39.091	-0.030
RH9P	Tool	Metal	9.90E+02	9.70E+02	1.021	1	40.909	0.020
RH9I	MSM Boot	Poly	6.30E+02	5.90E+02	1.068	1	42.727	0.066
RH9J	Lid	Poly	5.20E+02	4.70E+02	1.106	1	44.545	0.101
RH9D	bckt	Poly	4.85E+02	4.30E+02	1.128	1	46.364	0.120
RH9R	Lid	Metal	2.15E+02	1.90E+02	1.132	1	48.182	0.124
RH9U	Wipes	Wipes	1.55E+02	1.20E+02	1.292	1	50.000	0.256
LN-7	tool	Metal	2.10E+03	1.50E+03	1.400	1	51.818	0.336
LN-ML	tool	Metal	7.30E+05	5.20E+05	1.404	1	53.636	0.339
RH9O	housing	Glass	5.25E+01	3.70E+01	1.419	1	55.455	0.350
LN-49	socket	Metal	1.20E+03	7.80E+02	1.538	1	57.273	0.431
RH9G	Valve	Poly	2.90E+02	1.80E+02	1.611	1	59.091	0.477
RH9F	Valve	Poly	4.00E+02	2.40E+02	1.667	1	60.909	0.511
LN-35	bottle	Poly	1.50E+04	8.90E+03	1.685	1	62.727	0.522
LN-41	column	Metal	4.80E+03	2.80E+03	1.714	1	64.545	0.539
LN-48	tool	Metal	3.90E+03	2.10E+03	1.857	1	66.364	0.619
RH9T	Wipes	Wipes	1.60E+02	6.80E+01	2.353	1	68.182	0.856
LN-1	bottle	Glass	1.10E+04	4.50E+03	2.444	1	70.000	0.894
LN-GL	bottles	Glass	1.20E+06	3.90E+05	3.077	1	71.818	1.124
LN-11	bottle	Glass	1.10E+04	3.40E+03	3.235	1	73.636	1.174
LN-25	bottle	Glass	2.70E+03	6.80E+02	3.971	1	75.455	1.379
RH9KK	Lid	Poly	5.75E+02	1.10E+02	5.227	1	77.273	1.654
LN-44	cap	Metal	3.50E+03	6.00E+02	5.833	1	79.091	1.764
LN-6	bottle	Glass	2.30E+04	3.60E+03	6.389	1	80.909	1.855
LN-4	bottle	Glass	1.30E+04	1.90E+03	6.842	1	82.727	1.923
LN-3	bottle	Glass	2.85E+04	3.80E+03	7.500	1	84.545	2.015
LN-19	bottle	Glass	9.05E+03	1.10E+03	8.227	1	86.364	2.107
LN-28	bottle	Glass	1.10E+04	1.30E+03	8.462	1	88.182	2.136
LN-8	bottle	Glass	1.60E+04	1.80E+03	8.889	1	90.000	2.185
LN-26	bottle	Glass	1.45E+04	1.00E+03	14.500	1	91.818	2.674
LN-13	bottle	Glass	2.30E+04	1.30E+03	17.692	1	93.636	2.873
LN-36	cell	Metal	2.90E+04	1.60E+03	18.125	1	95.455	2.897
LN-9	bulb	Glass	2.05E+04	7.90E+02	25.949	1	97.273	3.256
LN-39	cell	Metal	3.90E+04	1.50E+03	26.000	1	99.091	3.258

C6. Activity ratios of alpha emitting radionuclides and Cs-137

Cm244/Cs137

Sample ID	Waste Component	Waste Group	Cm244 (Bq/total)	Cs137 (Bq/total)	Cm244/Cs137 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottles	Glass	1.50E+04	6.70E+06	0.002	1	0.909	-6.102
LN-11	bottle	Glass	1.10E+04	4.50E+04	0.244	1	2.727	-1.409
LN-ML	tool	Metal	5.50E+04	1.50E+05	0.367	1	4.545	-1.003
LN-13	bottle	Glass	3.40E+03	8.60E+03	0.395	1	6.364	-0.928
LN-40	hose	Poly	1.50E+04	1.70E+04	0.882	1	8.182	-0.125
LN-36	cell	Metal	1.00E+04	6.30E+03	1.587	1	10.000	0.462
LN-39	cell	Metal	8.30E+03	4.40E+03	1.886	1	11.818	0.635
LN-6	bottle	Glass	9.30E+04	4.80E+04	1.938	1	13.636	0.661
LN-9	bulb	Glass	2.10E+04	5.20E+03	4.038	1	15.455	1.396
LN-44	cap	Metal	2.40E+04	3.90E+03	6.154	1	17.273	1.817
LN-41	column	Metal	5.40E+04	6.30E+03	8.571	1	19.091	2.148
LN-19	bottle	Glass	4.20E+04	4.60E+03	9.130	1	20.909	2.212
LN-48	tool	Metal	4.90E+04	4.60E+03	10.652	1	22.727	2.366
LN-26	bottle	Glass	4.60E+04	3.50E+03	13.143	1	24.545	2.576
LN-46	can	Metal	3.30E+04	2.20E+03	15.000	1	26.364	2.708
LN-54	case	Metal	5.80E+04	3.00E+03	19.333	1	28.182	2.962
LN-33	valve	Poly	1.90E+05	7.80E+03	24.359	1	30.000	3.193
RH9J	Lid	Poly	5.20E+04	1.80E+03	28.889	1	31.818	3.363
LN-8	bottle	Glass	3.80E+05	1.10E+04	34.545	1	33.636	3.542
LN-4	bottle	Glass	2.00E+05	3.60E+03	55.556	1	35.455	4.017
RH9M	bottle	Glass	1.50E+05	2.50E+03	60.000	1	37.273	4.094
RH9P	Tool	Metal	8.20E+04	1.20E+03	68.333	1	39.091	4.224
LN-1	bottle	Glass	1.40E+06	2.00E+04	70.000	1	40.909	4.248
LN-7	tool	Metal	6.00E+04	8.20E+02	73.171	1	42.727	4.293
RH9I	MSM Boot	Poly	9.40E+04	9.90E+02	94.949	1	44.545	4.553
LN-49	socket	Metal	1.20E+05	8.70E+02	137.931	1	46.364	4.927
RH9E	Valve	Poly	9.70E+04	6.20E+02	156.452	1	48.182	5.053
LN-3	bottle	Glass	1.40E+06	8.80E+03	159.091	1	50.000	5.069
LN-28	bottle	Glass	1.10E+06	6.90E+03	159.420	1	51.818	5.072
RH9G	Valve	Poly	2.80E+04	1.70E+02	164.706	1	53.636	5.104
RH9F	Valve	Poly	2.00E+05	1.20E+03	166.667	1	55.455	5.116
RH9H	Light Cord	Poly	1.00E+05	5.00E+02	200.000	1	57.273	5.298
LN-38	tool	Metal	5.30E+05	1.90E+03	278.947	1	59.091	5.631
RH9EE	Valve	Poly	5.90E+05	1.90E+03	310.526	1	60.909	5.738
RH9S	Wipes	Wipes	2.30E+06	6.90E+03	333.333	1	62.727	5.809
LN-35	bottle	Poly	1.40E+06	3.80E+03	368.421	1	64.545	5.909
RH9C	Melt	Poly	1.70E+05	3.70E+02	459.459	1	66.364	6.130
RH9L	bottle	Glass	3.40E+05	6.50E+02	523.077	1	68.182	6.260
RH9N	glassware	Glass	9.00E+05	1.50E+03	600.000	1	70.000	6.397
RH9LL	bottle	Glass	1.10E+06	1.60E+03	687.500	1	71.818	6.533
RH9A	Melt	Poly	1.80E+05	1.90E+02	947.368	1	73.636	6.854
RH9K	Lid	Poly	1.40E+06	1.40E+03	1000.000	1	75.455	6.908
LN-15	tool	Metal	1.10E+06	1.00E+03	1100.000	1	77.273	7.003
RH9QQ	Wire	Metal	2.00E+06	1.30E+03	1538.462	1	79.091	7.339
RH9KK	Lid	Poly	3.80E+05	1.80E+02	2111.111	1	80.909	7.655
RH9Q	Wire	Metal	6.60E+05	3.10E+02	2129.032	1	82.727	7.663
RH9D	bckt	Poly	1.30E+06	5.70E+02	2280.702	1	84.545	7.732
RH9R	Lid	Metal	1.60E+06	4.00E+02	4000.000	2	88.182	8.294
RH9SS	Wipes	Wipes	2.80E+06	7.00E+02	4000.000	0	88.182	8.294
RH9O	housing	Glass	6.00E+05	9.90E+01	6060.606	1	90.000	8.710
RH9V	Wipes	Wipes	9.40E+06	8.50E+02	11058.824	1	91.818	9.311
RH9T	Wipes	Wipes	2.30E+06	6.30E+01	36507.937	1	93.636	10.505
RH9U	Wipes	Wipes	1.30E+07	1.40E+02	92857.143	1	95.455	11.439
LN-25	bottle	Glass	1.20E+08	1.10E+03	109090.909	1	97.273	11.600
RH9AA	Melt	Poly	6.90E+07	9.80E+01	704081.633	1	99.091	13.465

Pu238/Cs137

Sample ID	Waste Component	Waste Group	Pu238 (Bq/total)	Cs137 (Bq/total)	Pu238/Cs137 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-40	hose	Poly	3.80E+02	1.70E+04	0.022	1	0.909	-3.801
LN-1	bottle	Glass	4.70E+02	2.00E+04	0.024	1	2.727	-3.751
LN-11	bottle	Glass	1.30E+03	4.50E+04	0.029	1	4.545	-3.544
RH9I	MSM Boot	Poly	3.50E+01	9.90E+02	0.035	2	8.182	-3.342
LN-6	bottle	Glass	1.70E+03	4.80E+04	0.035	0	8.182	-3.341
RH9M	bottle	Glass	1.00E+02	2.50E+03	0.040	2	11.818	-3.219
LN-GL	bottles	Glass	2.70E+05	6.70E+06	0.040	0	11.818	-3.211
RH9H	Light Cord	Poly	2.90E+01	5.00E+02	0.058	1	13.636	-2.847
LN-8	bottle	Glass	7.90E+02	1.10E+04	0.072	1	15.455	-2.634
RH9LL	bottle	Glass	1.20E+02	1.60E+03	0.075	1	17.273	-2.590
LN-9	bulb	Glass	6.60E+02	5.20E+03	0.127	1	19.091	-2.064
LN-13	bottle	Glass	1.10E+03	8.60E+03	0.128	1	20.909	-2.056
RH9J	Lid	Poly	2.70E+02	1.80E+03	0.150	1	22.727	-1.897
RH9SS	Wipes	Wipes	1.10E+02	7.00E+02	0.157	1	24.545	-1.851
LN-3	bottle	Glass	1.40E+03	8.80E+03	0.159	1	26.364	-1.838
LN-28	bottle	Glass	1.40E+03	6.90E+03	0.203	1	28.182	-1.595
RH9S	Wipes	Wipes	1.50E+03	6.90E+03	0.217	1	30.000	-1.526
LN-19	bottle	Glass	1.10E+03	4.60E+03	0.239	1	31.818	-1.431
LN-4	bottle	Glass	9.80E+02	3.60E+03	0.272	1	33.636	-1.301
LN-26	bottle	Glass	1.10E+03	3.50E+03	0.314	1	35.455	-1.157
LN-41	column	Metal	2.00E+03	6.30E+03	0.317	1	37.273	-1.147
LN-48	tool	Metal	1.60E+03	4.60E+03	0.348	1	39.091	-1.056
LN-38	tool	Metal	6.90E+02	1.90E+03	0.363	1	40.909	-1.013
LN-36	cell	Metal	2.30E+03	6.30E+03	0.365	1	42.727	-1.008
LN-25	bottle	Glass	4.40E+02	1.10E+03	0.400	1	44.545	-0.916
RH9V	Wipes	Wipes	3.60E+02	8.50E+02	0.424	1	46.364	-0.859
LN-49	socket	Metal	4.00E+02	8.70E+02	0.460	1	48.182	-0.777
LN-54	case	Metal	1.40E+03	3.00E+03	0.467	1	50.000	-0.762
RH9E	Valve	Poly	3.00E+02	6.20E+02	0.484	1	51.818	-0.726
RH9K	Lid	Poly	6.80E+02	1.40E+03	0.486	1	53.636	-0.722
LN-46	can	Metal	1.10E+03	2.20E+03	0.500	1	55.455	-0.693
RH9O	housing	Glass	5.25E+01	9.90E+01	0.530	1	57.273	-0.634
RH9R	Lid	Metal	2.40E+02	4.00E+02	0.600	1	59.091	-0.511
LN-39	cell	Metal	3.00E+03	4.40E+03	0.682	1	60.909	-0.383
RH9A	Melt	Poly	1.30E+02	1.90E+02	0.684	1	62.727	-0.379
RH9L	bottle	Glass	5.00E+02	6.50E+02	0.769	1	64.545	-0.262
LN-44	cap	Metal	3.10E+03	3.90E+03	0.795	1	66.364	-0.230
LN-33	valve	Poly	6.40E+03	7.80E+03	0.821	1	68.182	-0.198
RH9P	Tool	Metal	9.90E+02	1.20E+03	0.825	1	70.000	-0.192
RH9F	Valve	Poly	1.00E+03	1.20E+03	0.833	1	71.818	-0.182
RH9D	bckt	Poly	4.85E+02	5.70E+02	0.851	1	73.636	-0.161
RH9U	Wipes	Wipes	1.55E+02	1.40E+02	1.107	1	75.455	0.102
RH9C	Melt	Poly	4.20E+02	3.70E+02	1.135	1	77.273	0.127
RH9N	glassware	Glass	1.95E+03	1.50E+03	1.300	1	79.091	0.262
RH9QQ	Wire	Metal	1.95E+03	1.30E+03	1.500	1	80.909	0.405
RH9AA	Melt	Poly	1.70E+02	9.80E+01	1.735	1	82.727	0.551
RH9Q	Wire	Metal	8.75E+02	3.10E+02	2.823	1	84.545	1.038
RH9EE	Valve	Poly	6.20E+03	1.90E+03	3.263	1	86.364	1.183
LN-35	bottle	Poly	1.40E+04	3.80E+03	3.684	1	88.182	1.304
LN-7	tool	Metal	3.40E+03	8.20E+02	4.146	1	90.000	1.422
RH9G	Valve	Poly	8.00E+02	1.70E+02	4.706	1	91.818	1.549
RH9KK	Lid	Poly	8.50E+02	1.80E+02	4.722	1	93.636	1.552
RH9T	Wipes	Wipes	3.90E+02	6.30E+01	6.190	1	95.455	1.823
LN-15	tool	Metal	6.30E+03	1.00E+03	6.300	1	97.273	1.841
LN-ML	tool	Metal	1.10E+06	1.50E+05	7.333	1	99.091	1.992

Pu*/Cs137

Sample ID	Waste Component	Waste Group	Pu* (Bq/total)	Cs137 (Bq/total)	Pu*/Cs137 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-ML	tool	Wipes	1.55E+02	1.50E+05	0.001	1	0.909	-6.875
LN-11	bottle	Glass	5.10E+02	4.50E+04	0.011	1	2.727	-4.480
LN-6	bottle	Metal	5.70E+02	4.80E+04	0.012	1	4.545	-4.433
LN-39	cell	Poly	5.80E+01	4.40E+03	0.013	1	6.364	-4.329
LN-3	bottle	Wipes	1.20E+02	8.80E+03	0.014	2	10.000	-4.295
LN-13	bottle	Glass	1.20E+02	8.60E+03	0.014	0	10.000	-4.272
LN-1	bottle	Poly	2.90E+02	2.00E+04	0.015	1	11.818	-4.234
LN-9	bulb	Poly	1.10E+02	5.20E+03	0.021	1	13.636	-3.856
LN-40	hose	Glass	4.60E+02	1.70E+04	0.027	1	15.455	-3.610
LN-8	bottle	Wipes	3.50E+02	1.10E+04	0.032	1	17.273	-3.448
RH9S	Wipes	Wipes	2.90E+02	6.90E+03	0.042	1	19.091	-3.169
LN-GL	bottles	Metal	2.90E+05	6.70E+06	0.043	1	20.909	-3.140
LN-48	tool	Poly	2.50E+02	4.60E+03	0.054	1	22.727	-2.912
LN-33	valve	Poly	4.85E+02	7.80E+03	0.062	1	24.545	-2.778
LN-41	column	Metal	4.00E+02	6.30E+03	0.063	1	26.364	-2.757
LN-46	can	Wipes	1.50E+02	2.20E+03	0.068	1	28.182	-2.686
LN-28	bottle	Metal	6.80E+02	6.90E+03	0.099	1	30.000	-2.317
LN-35	bottle	Poly	5.20E+02	3.80E+03	0.137	2	33.636	-1.989
LN-26	bottle	Metal	4.80E+02	3.50E+03	0.137	0	33.636	-1.987
RH9N	glassware	Poly	2.60E+02	1.50E+03	0.173	1	35.455	-1.753
LN-54	case	Poly	6.20E+02	3.00E+03	0.207	1	37.273	-1.577
RH9EE	Valve	Metal	4.00E+02	1.90E+03	0.211	1	39.091	-1.558
LN-44	cap	Metal	1.10E+03	3.90E+03	0.282	1	40.909	-1.266
LN-36	cell	Metal	2.10E+03	6.30E+03	0.333	1	42.727	-1.099
RH9F	Valve	Poly	5.00E+02	1.20E+03	0.417	1	44.545	-0.875
LN-19	bottle	Glass	2.00E+03	4.60E+03	0.435	1	46.364	-0.833
LN-49	socket	Glass	4.00E+02	8.70E+02	0.460	1	48.182	-0.777
RH9A	Melt	Poly	9.10E+01	1.90E+02	0.479	1	50.000	-0.736
LN-38	tool	Metal	9.30E+02	1.90E+03	0.489	1	51.818	-0.714
RH9H	Light Cord	Poly	2.60E+02	5.00E+02	0.520	2	55.455	-0.654
RH9I	MSM Boot	Poly	5.15E+02	9.90E+02	0.520	0	55.455	-0.654
RH9J	Lid	Glass	1.10E+03	1.80E+03	0.611	1	57.273	-0.492
RH9D	bckt	Poly	4.40E+02	5.70E+02	0.772	1	59.091	-0.259
RH9C	Melt	Glass	3.00E+02	3.70E+02	0.811	1	60.909	-0.210
RH9LL	bottle	Metal	1.80E+03	1.60E+03	1.125	1	62.727	0.118
RH9KK	Lid	Metal	2.15E+02	1.80E+02	1.194	1	64.545	0.178
RH9E	Valve	Metal	9.50E+02	6.20E+02	1.532	1	66.364	0.427
LN-4	bottle	Glass	6.90E+03	3.60E+03	1.917	1	68.182	0.651
RH9M	bottle	Glass	4.90E+03	2.50E+03	1.960	1	70.000	0.673
RH9G	Valve	Poly	3.50E+02	1.70E+02	2.059	1	71.818	0.722
RH9L	bottle	Metal	1.40E+03	6.50E+02	2.154	1	73.636	0.767
LN-25	bottle	Poly	3.60E+03	1.10E+03	3.273	1	75.455	1.186
RH9P	Tool	Glass	4.70E+03	1.20E+03	3.917	1	77.273	1.365
RH9K	Lid	Poly	5.50E+03	1.40E+03	3.929	1	79.091	1.368
RH9QQ	Wire	Glass	6.30E+03	1.30E+03	4.846	1	80.909	1.578
LN-7	tool	Glass	4.00E+03	8.20E+02	4.878	1	82.727	1.585
RH9SS	Wipes	Metal	3.80E+03	7.00E+02	5.429	1	84.545	1.692
RH9U	Wipes	Metal	8.75E+02	1.40E+02	6.250	1	86.364	1.833
RH9V	Wipes	Glass	8.90E+03	8.50E+02	10.471	1	88.182	2.349
RH9AA	Melt	Glass	1.10E+03	9.80E+01	11.224	1	90.000	2.418
RH9R	Lid	Glass	6.60E+03	4.00E+02	16.500	1	91.818	2.803
RH9Q	Wire	Metal	6.20E+03	3.10E+02	20.000	1	93.636	2.996
RH9O	housing	Glass	4.00E+03	9.90E+01	40.404	1	95.455	3.699
RH9T	Wipes	Glass	6.30E+03	6.30E+01	100.000	1	97.273	4.605
LN-15	tool	Glass	3.20E+05	1.00E+03	320.000	1	99.091	5.768

Pu242/Cs137

Sample ID	Waste Component	Waste Group	Pu242 (Bq/total)	Cs137 (Bq/total)	Pu242/Cs137 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-6	bottle	Glass	1.60E+01	4.80E+04	0.000	2	2.727	-8.006
LN-11	bottle	Glass	2.00E+01	4.50E+04	0.000	0	2.727	-7.719
LN-40	hose	Poly	8.70E+00	1.70E+04	0.001	3	8.182	-7.578
LN-GL	bottles	Glass	4.20E+03	6.70E+06	0.001	0	8.182	-7.375
LN-1	bottle	Glass	2.00E+01	2.00E+04	0.001	0	8.182	-6.908
LN-3	bottle	Glass	1.50E+01	8.80E+03	0.002	3	13.636	-6.374
LN-39	cell	Metal	9.30E+00	4.40E+03	0.002	0	13.636	-6.159
LN-13	bottle	Glass	2.00E+01	8.60E+03	0.002	0	13.636	-6.064
LN-48	tool	Metal	1.30E+01	4.60E+03	0.003	1	15.455	-5.869
LN-36	cell	Metal	2.40E+01	6.30E+03	0.004	2	19.091	-5.570
LN-8	bottle	Glass	4.40E+01	1.10E+04	0.004	0	19.091	-5.521
LN-41	column	Metal	3.30E+01	6.30E+03	0.005	1	20.909	-5.252
LN-4	bottle	Glass	2.00E+01	3.60E+03	0.006	2	24.545	-5.193
LN-33	valve	Poly	5.00E+01	7.80E+03	0.006	0	24.545	-5.050
LN-19	bottle	Glass	3.20E+01	4.60E+03	0.007	3	30.000	-4.968
LN-28	bottle	Glass	4.90E+01	6.90E+03	0.007	0	30.000	-4.947
LN-25	bottle	Glass	8.00E+00	1.10E+03	0.007	0	30.000	-4.924
LN-9	bulb	Glass	3.90E+01	5.20E+03	0.008	2	33.636	-4.893
LN-46	can	Metal	1.70E+01	2.20E+03	0.008	0	33.636	-4.863
LN-54	case	Metal	3.40E+01	3.00E+03	0.011	1	35.455	-4.480
LN-44	cap	Metal	4.60E+01	3.90E+03	0.012	1	37.273	-4.440
LN-38	tool	Metal	2.80E+01	1.90E+03	0.015	1	39.091	-4.217
LN-26	bottle	Glass	6.50E+01	3.50E+03	0.019	1	40.909	-3.986
LN-35	bottle	Poly	2.00E+02	3.80E+03	0.053	1	42.727	-2.944
LN-7	tool	Metal	4.80E+01	8.20E+02	0.059	1	44.545	-2.838
LN-15	tool	Metal	6.60E+01	1.00E+03	0.066	1	46.364	-2.718
RH9LL	bottle	Glass	1.20E+02	1.60E+03	0.075	1	48.182	-2.590
LN-ML	tool	Metal	1.30E+04	1.50E+05	0.087	1	50.000	-2.446
LN-49	socket	Metal	8.20E+01	8.70E+02	0.094	1	51.818	-2.362
RH9S	Wipes	Wipes	1.50E+03	6.90E+03	0.217	1	53.636	-1.526
RH9J	Lid	Poly	5.20E+02	1.80E+03	0.289	1	55.455	-1.242
RH9M	bottle	Glass	1.00E+03	2.50E+03	0.400	1	57.273	-0.916
RH9E	Valve	Poly	2.60E+02	6.20E+02	0.419	1	59.091	-0.869
RH9O	housing	Glass	5.25E+01	9.90E+01	0.530	1	60.909	-0.634
RH9R	Lid	Metal	2.15E+02	4.00E+02	0.538	1	62.727	-0.621
RH9A	Melt	Poly	1.10E+02	1.90E+02	0.579	1	64.545	-0.547
RH9I	MSM Boot	Poly	6.35E+02	9.90E+02	0.641	1	66.364	-0.444
RH9V	Wipes	Wipes	5.85E+02	8.50E+02	0.688	1	68.182	-0.374
RH9K	Lid	Poly	1.10E+03	1.40E+03	0.786	1	70.000	-0.241
RH9P	Tool	Metal	9.90E+02	1.20E+03	0.825	1	71.818	-0.192
RH9F	Valve	Poly	1.00E+03	1.20E+03	0.833	1	73.636	-0.182
RH9D	bckt	Poly	4.85E+02	5.70E+02	0.851	1	75.455	-0.161
RH9SS	Wipes	Wipes	6.10E+02	7.00E+02	0.871	1	77.273	-0.138
RH9L	bottle	Glass	6.00E+02	6.50E+02	0.923	1	79.091	-0.080
RH9AA	Melt	Poly	9.10E+01	9.80E+01	0.929	1	80.909	-0.074
RH9C	Melt	Poly	3.50E+02	3.70E+02	0.946	1	82.727	-0.056
RH9H	Light Cord	Poly	5.15E+02	5.00E+02	1.030	1	84.545	0.030
RH9U	Wipes	Wipes	1.55E+02	1.40E+02	1.107	1	86.364	0.102
RH9N	glassware	Glass	1.95E+03	1.50E+03	1.300	1	88.182	0.262
RH9QQ	Wire	Metal	1.95E+03	1.30E+03	1.500	1	90.000	0.405
RH9G	Valve	Poly	2.90E+02	1.70E+02	1.706	1	91.818	0.534
RH9T	Wipes	Wipes	1.65E+02	6.30E+01	2.619	1	93.636	0.963
RH9Q	Wire	Metal	8.75E+02	3.10E+02	2.823	1	95.455	1.038
RH9KK	Lid	Poly	5.75E+02	1.80E+02	3.194	1	97.273	1.161
RH9EE	Valve	Poly	6.20E+03	1.90E+03	3.263	1	99.091	1.183

Am241/Cs137

Sample ID	Waste Component	Waste Group	Am241 (Bq/total)	Cs137 (Bq/total)	Am241/Cs137 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottles	Glass	6.20E+05	6.70E+06	0.093	1	0.909	-2.380
LN-11	bottle	Glass	6.20E+03	4.50E+04	0.138	1	2.727	-1.982
LN-6	bottle	Glass	7.10E+03	4.80E+04	0.148	1	4.545	-1.911
LN-3	bottle	Glass	2.50E+03	8.80E+03	0.284	1	6.364	-1.258
LN-9	bulb	Glass	1.50E+03	5.20E+03	0.288	1	8.182	-1.243
LN-8	bottle	Glass	3.20E+03	1.10E+04	0.291	1	10.000	-1.235
RH9S	Wipes	Wipes	2.10E+03	6.90E+03	0.304	1	11.818	-1.190
LN-28	bottle	Glass	2.20E+03	6.90E+03	0.319	1	13.636	-1.143
LN-13	bottle	Glass	2.80E+03	8.60E+03	0.326	1	15.455	-1.122
LN-1	bottle	Glass	7.30E+03	2.00E+04	0.365	1	17.273	-1.008
RH9F	Valve	Poly	4.60E+02	1.20E+03	0.383	1	19.091	-0.959
RH9J	Lid	Poly	7.20E+02	1.80E+03	0.400	1	20.909	-0.916
LN-19	bottle	Glass	1.90E+03	4.60E+03	0.413	1	22.727	-0.884
LN-26	bottle	Glass	1.70E+03	3.50E+03	0.486	1	24.545	-0.722
RH9LL	bottle	Glass	8.50E+02	1.60E+03	0.531	1	26.364	-0.633
RH9O	housing	Glass	5.40E+01	9.90E+01	0.545	1	28.182	-0.606
RH9R	Lid	Metal	2.20E+02	4.00E+02	0.550	1	30.000	-0.598
RH9M	bottle	Glass	1.40E+03	2.50E+03	0.560	1	31.818	-0.580
LN-44	cap	Metal	2.20E+03	3.90E+03	0.564	1	33.636	-0.573
RH9E	Valve	Poly	3.50E+02	6.20E+02	0.565	1	35.455	-0.572
LN-4	bottle	Glass	2.20E+03	3.60E+03	0.611	1	37.273	-0.492
LN-40	hose	Poly	1.10E+04	1.70E+04	0.647	1	39.091	-0.435
LN-48	tool	Metal	3.70E+03	4.60E+03	0.804	1	40.909	-0.218
RH9SS	Wipes	Wipes	6.20E+02	7.00E+02	0.886	1	42.727	-0.121
RH9V	Wipes	Wipes	7.60E+02	8.50E+02	0.894	1	44.545	-0.112
LN-38	tool	Metal	1.70E+03	1.90E+03	0.895	1	46.364	-0.111
LN-46	can	Metal	2.00E+03	2.20E+03	0.909	1	48.182	-0.095
RH9I	MSM Boot	Poly	9.10E+02	9.90E+02	0.919	1	50.000	-0.084
RH9K	Lid	Poly	1.30E+03	1.40E+03	0.929	1	51.818	-0.074
RH9G	Valve	Poly	1.60E+02	1.70E+02	0.941	1	53.636	-0.061
LN-49	socket	Metal	8.90E+02	8.70E+02	1.023	1	55.455	0.023
LN-41	column	Metal	7.20E+03	6.30E+03	1.143	1	57.273	0.134
RH9A	Melt	Poly	2.20E+02	1.90E+02	1.158	1	59.091	0.147
RH9L	bottle	Glass	8.20E+02	6.50E+02	1.262	1	60.909	0.232
RH9T	Wipes	Wipes	8.70E+01	6.30E+01	1.381	1	62.727	0.323
RH9KK	Lid	Poly	2.50E+02	1.80E+02	1.389	1	64.545	0.329
RH9EE	Valve	Poly	2.80E+03	1.90E+03	1.474	1	66.364	0.388
LN-54	case	Metal	5.20E+03	3.00E+03	1.733	1	68.182	0.550
RH9AA	Melt	Poly	1.70E+02	9.80E+01	1.735	1	70.000	0.551
RH9D	bckt	Poly	1.00E+03	5.70E+02	1.754	1	71.818	0.562
RH9P	Tool	Metal	2.20E+03	1.20E+03	1.833	1	73.636	0.606
RH9H	Light Cord	Poly	9.40E+02	5.00E+02	1.880	1	75.455	0.631
LN-33	valve	Poly	1.50E+04	7.80E+03	1.923	1	77.273	0.654
RH9C	Melt	Poly	7.40E+02	3.70E+02	2.000	1	79.091	0.693
RH9U	Wipes	Wipes	3.20E+02	1.40E+02	2.286	1	80.909	0.827
LN-7	tool	Metal	2.50E+03	8.20E+02	3.049	1	82.727	1.115
RH9QQ	Wire	Metal	5.60E+03	1.30E+03	4.308	1	84.545	1.460
LN-25	bottle	Glass	4.90E+03	1.10E+03	4.455	1	86.364	1.494
LN-15	tool	Metal	5.90E+03	1.00E+03	5.900	1	88.182	1.775
LN-ML	tool	Metal	9.30E+05	1.50E+05	6.200	1	90.000	1.825
RH9N	glassware	Glass	1.10E+04	1.50E+03	7.333	1	91.818	1.992
RH9Q	Wire	Metal	3.00E+03	3.10E+02	9.677	1	93.636	2.270
LN-36	cell	Metal	8.30E+04	6.30E+03	13.175	1	95.455	2.578
LN-35	bottle	Poly	5.80E+04	3.80E+03	15.263	1	97.273	2.725
LN-39	cell	Metal	1.10E+05	4.40E+03	25.000	1	99.091	3.219

Am243/Cs137

Sample ID	Waste Component	Waste Group	Am243 (Bq/total)	Cs137 (Bq/total)	Am243/Cs137 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-11	bottle	Glass	4.10E+02	4.50E+04	0.009	1	0.909	-4.698
LN-GL	bottles	Glass	7.10E+04	6.70E+06	0.011	1	2.727	-4.547
LN-6	bottle	Glass	6.80E+02	4.80E+04	0.014	1	4.545	-4.257
RH9J	Lid	Poly	2.90E+01	1.80E+03	0.016	1	6.364	-4.128
RH9F	Valve	Poly	2.40E+01	1.20E+03	0.020	1	8.182	-3.912
LN-1	bottle	Glass	4.50E+02	2.00E+04	0.023	1	10.000	-3.794
RH9R	Lid	Metal	1.00E+01	4.00E+02	0.025	1	11.818	-3.689
RH9LL	bottle	Glass	4.20E+01	1.60E+03	0.026	1	13.636	-3.640
RH9A	Melt	Poly	5.10E+00	1.90E+02	0.027	1	15.455	-3.618
LN-19	bottle	Glass	1.40E+02	4.60E+03	0.030	1	17.273	-3.492
LN-48	tool	Metal	1.50E+02	4.60E+03	0.033	2	20.909	-3.423
LN-41	column	Metal	2.10E+02	6.30E+03	0.033	0	20.909	-3.401
LN-8	bottle	Glass	3.70E+02	1.10E+04	0.034	1	22.727	-3.392
LN-13	bottle	Glass	3.00E+02	8.60E+03	0.035	1	24.545	-3.356
RH9M	bottle	Glass	8.90E+01	2.50E+03	0.036	1	26.364	-3.335
RH9O	housing	Glass	4.00E+00	9.90E+01	0.040	1	28.182	-3.209
LN-28	bottle	Glass	2.90E+02	6.90E+03	0.042	2	31.818	-3.169
RH9I	MSM Boot	Poly	4.20E+01	9.90E+02	0.042	0	31.818	-3.160
RH9S	Wipes	Wipes	3.20E+02	6.90E+03	0.046	1	33.636	-3.071
LN-44	cap	Metal	1.90E+02	3.90E+03	0.049	2	37.273	-3.022
RH9D	bckt	Poly	2.80E+01	5.70E+02	0.049	0	37.273	-3.013
LN-46	can	Metal	1.10E+02	2.20E+03	0.050	1	39.091	-2.996
RH9SS	Wipes	Wipes	3.60E+01	7.00E+02	0.051	1	40.909	-2.968
RH9E	Valve	Poly	3.20E+01	6.20E+02	0.052	3	46.364	-2.964
RH9L	bottle	Glass	3.40E+01	6.50E+02	0.052	0	46.364	-2.951
RH9G	Valve	Poly	8.90E+00	1.70E+02	0.052	0	46.364	-2.950
RH9C	Melt	Poly	2.10E+01	3.70E+02	0.057	2	50.000	-2.869
RH9U	Wipes	Wipes	8.00E+00	1.40E+02	0.057	0	50.000	-2.862
RH9K	Lid	Poly	8.10E+01	1.40E+03	0.058	1	51.818	-2.850
LN-9	bulb	Glass	3.10E+02	5.20E+03	0.060	1	53.636	-2.820
RH9KK	Lid	Poly	1.10E+01	1.80E+02	0.061	1	55.455	-2.795
LN-3	bottle	Glass	5.70E+02	8.80E+03	0.065	1	57.273	-2.737
RH9N	glassware	Glass	1.00E+02	1.50E+03	0.067	1	59.091	-2.708
LN-26	bottle	Glass	2.40E+02	3.50E+03	0.069	1	60.909	-2.680
RH9P	Tool	Metal	9.60E+01	1.20E+03	0.080	1	62.727	-2.526
RH9V	Wipes	Wipes	6.90E+01	8.50E+02	0.081	1	64.545	-2.511
LN-38	tool	Metal	1.70E+02	1.90E+03	0.089	1	66.364	-2.414
RH9H	Light Cord	Poly	4.60E+01	5.00E+02	0.092	1	68.182	-2.386
RH9QQ	Wire	Metal	1.20E+02	1.30E+03	0.092	1	70.000	-2.383
LN-35	bottle	Poly	3.70E+02	3.80E+03	0.097	1	71.818	-2.329
LN-7	tool	Metal	8.00E+01	8.20E+02	0.098	1	73.636	-2.327
LN-49	socket	Metal	8.80E+01	8.70E+02	0.101	1	75.455	-2.291
LN-54	case	Metal	3.20E+02	3.00E+03	0.107	1	77.273	-2.238
RH9EE	Valve	Poly	2.10E+02	1.90E+03	0.111	1	79.091	-2.203
RH9AA	Melt	Poly	1.10E+01	9.80E+01	0.112	1	80.909	-2.187
LN-4	bottle	Glass	4.10E+02	3.60E+03	0.114	1	82.727	-2.173
RH9T	Wipes	Wipes	7.50E+00	6.30E+01	0.119	1	84.545	-2.128
RH9Q	Wire	Metal	4.30E+01	3.10E+02	0.139	1	86.364	-1.975
LN-36	cell	Metal	1.00E+03	6.30E+03	0.159	1	88.182	-1.841
LN-33	valve	Poly	1.30E+03	7.80E+03	0.167	1	90.000	-1.792
LN-25	bottle	Glass	2.20E+02	1.10E+03	0.200	1	91.818	-1.609
LN-39	cell	Metal	1.20E+03	4.40E+03	0.273	1	93.636	-1.299
LN-15	tool	Metal	2.90E+02	1.00E+03	0.290	1	95.455	-1.238
LN-ML	tool	Metal	4.90E+04	1.50E+05	0.327	1	97.273	-1.119
LN-40	hose	Poly	5.80E+03	1.70E+04	0.341	1	99.091	-1.075

Cf252/Cs137

Sample ID	Waste Component	Waste Group	Cf252 (Bq/total)	Cs137 (Bq/total)	Cf252/Cs137 X(s,g)	Frequency	Cummulative Probability	Ln [X(s,g)]
RH9S	Wipes	Wipes	3.90E+02	6.90E+03	0.057	1	0.909	-2.873
LN-6	bottle	Glass	3.20E+03	4.80E+04	0.067	1	2.727	-2.708
RH9LL	bottle	Glass	1.80E+02	1.60E+03	0.113	1	4.545	-2.185
LN-11	bottle	Glass	5.50E+03	4.50E+04	0.122	1	6.364	-2.102
LN-GL	bottles	Glass	1.30E+06	6.70E+06	0.194	1	8.182	-1.640
LN-8	bottle	Glass	2.80E+03	1.10E+04	0.255	1	10.000	-1.368
LN-13	bottle	Glass	2.50E+03	8.60E+03	0.291	1	11.818	-1.235
LN-3	bottle	Glass	2.60E+03	8.80E+03	0.295	1	13.636	-1.219
LN-28	bottle	Glass	2.10E+03	6.90E+03	0.304	1	15.455	-1.190
LN-44	cap	Metal	1.20E+03	3.90E+03	0.308	2	19.091	-1.179
LN-9	bulb	Glass	1.60E+03	5.20E+03	0.308	0	19.091	-1.179
LN-19	bottle	Glass	2.10E+03	4.60E+03	0.457	1	20.909	-0.784
LN-48	tool	Metal	2.50E+03	4.60E+03	0.543	1	22.727	-0.610
RH9F	Valve	Poly	8.10E+02	1.20E+03	0.675	1	24.545	-0.393
LN-4	bottle	Glass	2.50E+03	3.60E+03	0.694	1	26.364	-0.365
LN-36	cell	Metal	4.50E+03	6.30E+03	0.714	1	28.182	-0.336
LN-1	bottle	Glass	1.60E+04	2.00E+04	0.800	1	30.000	-0.223
LN-46	can	Metal	1.80E+03	2.20E+03	0.818	1	31.818	-0.201
LN-54	case	Metal	2.50E+03	3.00E+03	0.833	1	33.636	-0.182
RH9G	Valve	Poly	1.50E+02	1.70E+02	0.882	1	35.455	-0.125
LN-49	socket	Metal	7.80E+02	8.70E+02	0.897	1	37.273	-0.109
RH9I	MSM Boot	Poly	9.40E+02	9.90E+02	0.949	1	39.091	-0.052
LN-41	column	Metal	6.00E+03	6.30E+03	0.952	1	40.909	-0.049
RH9R	Lid	Metal	3.90E+02	4.00E+02	0.975	1	42.727	-0.025
LN-25	bottle	Glass	1.10E+03	1.10E+03	1.000	3	48.182	0.000
LN-38	tool	Metal	1.90E+03	1.90E+03	1.000	0	48.182	0.000
RH9P	Tool	Metal	1.20E+03	1.20E+03	1.000	0	48.182	0.000
LN-40	hose	Poly	1.80E+04	1.70E+04	1.059	1	50.000	0.057
RH9E	Valve	Poly	7.20E+02	6.20E+02	1.161	1	51.818	0.150
LN-39	cell	Metal	5.20E+03	4.40E+03	1.182	1	53.636	0.167
RH9M	bottle	Glass	3.20E+03	2.50E+03	1.280	1	55.455	0.247
RH9H	Light Cord	Poly	7.00E+02	5.00E+02	1.400	1	57.273	0.336
RH9A	Melt	Poly	2.80E+02	1.90E+02	1.474	1	59.091	0.388
RH9D	bckt	Poly	8.80E+02	5.70E+02	1.544	1	60.909	0.434
RH9EE	Valve	Poly	3.10E+03	1.90E+03	1.632	1	62.727	0.490
LN-26	bottle	Glass	5.80E+03	3.50E+03	1.657	1	64.545	0.505
LN-33	valve	Poly	1.30E+04	7.80E+03	1.667	1	66.364	0.511
RH9SS	Wipes	Wipes	1.20E+03	7.00E+02	1.714	1	68.182	0.539
RH9C	Melt	Poly	6.60E+02	3.70E+02	1.784	1	70.000	0.579
RH9N	glassware	Glass	2.90E+03	1.50E+03	1.933	1	71.818	0.659
RH9K	Lid	Poly	3.10E+03	1.40E+03	2.214	1	73.636	0.795
RH9U	Wipes	Wipes	3.20E+02	1.40E+02	2.286	1	75.455	0.827
RH9AA	Melt	Poly	2.30E+02	9.80E+01	2.347	1	77.273	0.853
RH9V	Wipes	Wipes	2.10E+03	8.50E+02	2.471	1	79.091	0.904
RH9QQ	Wire	Metal	3.40E+03	1.30E+03	2.615	1	80.909	0.961
RH9Q	Wire	Metal	8.40E+02	3.10E+02	2.710	1	82.727	0.997
RH9L	bottle	Glass	1.90E+03	6.50E+02	2.923	1	84.545	1.073
RH9T	Wipes	Wipes	2.00E+02	6.30E+01	3.175	1	86.364	1.155
RH9J	Lid	Poly	7.10E+03	1.80E+03	3.944	1	88.182	1.372
LN-35	bottle	Poly	2.10E+04	3.80E+03	5.526	1	90.000	1.710
LN-7	tool	Metal	4.80E+03	8.20E+02	5.854	1	91.818	1.767
LN-15	tool	Metal	1.00E+04	1.00E+03	10.000	1	93.636	2.303
LN-ML	tool	Metal	2.00E+06	1.50E+05	13.333	1	95.455	2.590
RH9O	housing	Glass	1.40E+03	9.90E+01	14.141	1	97.273	2.649
RH9KK	Lid	Poly	2.70E+03	1.80E+02	15.000	1	99.091	2.708

Cm242/Cs137

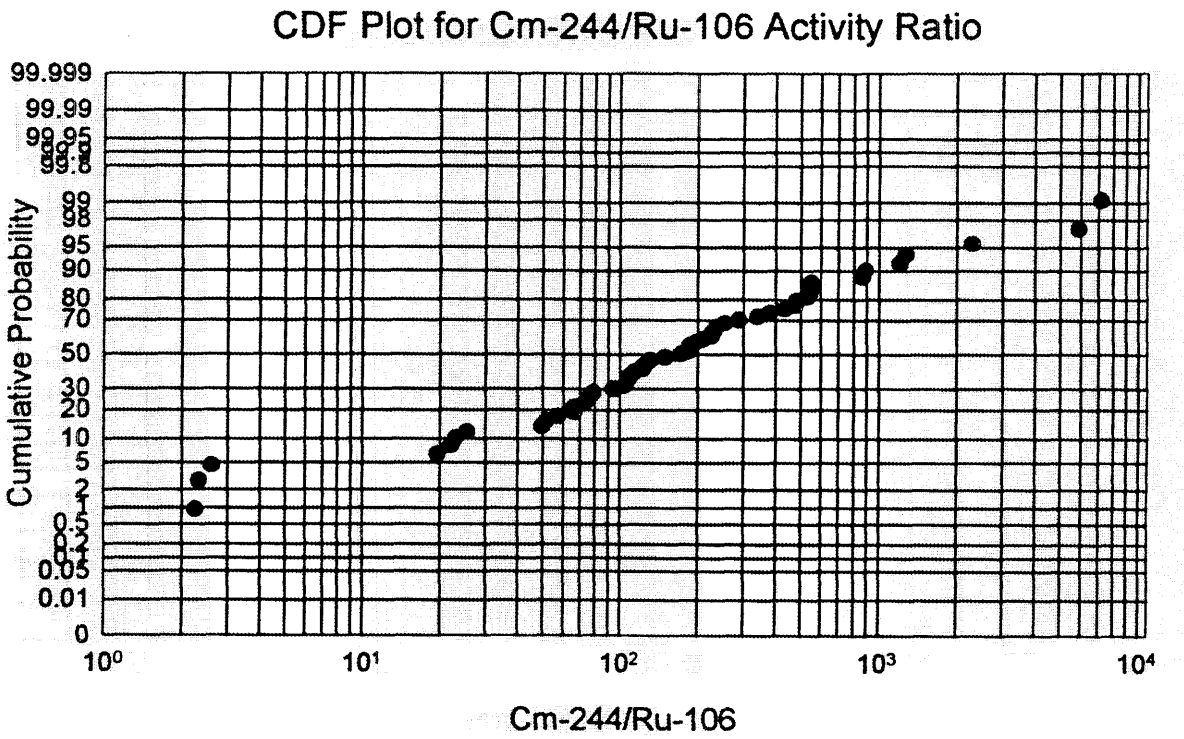
Sample ID	Waste Component	Waste Group	Cm242 (Bq/total)	Cs137 (Bq/total)	Cm242/Cs137 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
LN-GL	bottle	Glass	3.10E+03	6.70E+06	0.000	1	0.909	-7.678
LN-11	bottle	Glass	1.20E+02	4.50E+04	0.003	1	2.727	-5.927
LN-ML	Wipes	Wipes	7.30E+02	1.50E+05	0.005	1	4.545	-5.325
LN-13	housing	Glass	5.30E+01	8.60E+03	0.006	1	6.364	-5.089
LN-41	Wipes	Wipes	2.10E+02	6.30E+03	0.033	1	8.182	-3.401
LN-28	socket	Metal	3.00E+02	6.90E+03	0.043	1	10.000	-3.135
LN-19	can	Metal	3.20E+02	4.60E+03	0.070	1	11.818	-2.665
LN-46	Valve	Poly	1.70E+02	2.20E+03	0.077	1	13.636	-2.560
LN-40	tool	Metal	1.50E+03	1.70E+04	0.088	1	15.455	-2.428
RH9EE	Melt	Poly	1.90E+02	1.90E+03	0.100	1	17.273	-2.303
LN-9	Valve	Poly	5.90E+02	5.20E+03	0.113	1	19.091	-2.176
LN-49	Valve	Poly	1.10E+02	8.70E+02	0.126	1	20.909	-2.068
LN-54	Light Cord	Poly	4.30E+02	3.00E+03	0.143	1	22.727	-1.943
LN-35	bottle	Glass	6.10E+02	3.80E+03	0.161	1	24.545	-1.829
RH9J	Lid	Metal	3.40E+02	1.80E+03	0.189	1	26.364	-1.667
LN-8	Lid	Poly	2.20E+03	1.10E+04	0.200	1	28.182	-1.609
LN-7	Melt	Poly	1.70E+02	8.20E+02	0.207	1	30.000	-1.574
LN-39	tool	Metal	1.40E+03	4.40E+03	0.318	1	31.818	-1.145
LN-4	bottle	Glass	1.20E+03	3.60E+03	0.333	1	33.636	-1.099
LN-38	bckt	Poly	8.00E+02	1.90E+03	0.421	1	35.455	-0.865
LN-36	bottle	Glass	2.70E+03	6.30E+03	0.429	1	37.273	-0.847
LN-26	column	Metal	1.70E+03	3.50E+03	0.486	1	39.091	-0.722
LN-48	case	Metal	2.30E+03	4.60E+03	0.500	1	40.909	-0.693
RH9K	Tool	Metal	8.00E+02	1.40E+03	0.571	1	42.727	-0.560
LN-1	hose	Poly	1.30E+04	2.00E+04	0.650	1	44.545	-0.431
LN-3	bottle	Glass	5.80E+03	8.80E+03	0.659	1	46.364	-0.417
RH9A	Wipes	Wipes	1.50E+02	1.90E+02	0.789	1	48.182	-0.236
RH9S	tool	Metal	5.70E+03	6.90E+03	0.826	1	50.000	-0.191
RH9E	Melt	Poly	5.30E+02	6.20E+02	0.855	1	51.818	-0.157
LN-33	valve	Poly	9.40E+03	7.80E+03	1.205	1	53.636	0.187
RH9D	Wipes	Wipes	9.50E+02	5.70E+02	1.667	1	55.455	0.511
RH9F	bottle	Glass	2.30E+03	1.20E+03	1.917	1	57.273	0.651
RH9C	MSM Boot	Poly	7.60E+02	3.70E+02	2.054	1	59.091	0.720
RH9I	bottle	Glass	2.10E+03	9.90E+02	2.121	1	60.909	0.752
RH9AA	Wipes	Wipes	2.90E+02	9.80E+01	2.959	1	62.727	1.085
RH9M	cell	Metal	7.80E+03	2.50E+03	3.120	1	64.545	1.138
RH9N	cell	Metal	5.00E+03	1.50E+03	3.333	2	68.182	1.204
RH9P	Wire	Metal	4.00E+03	1.20E+03	3.333	0	68.182	1.204
RH9SS	Lid	Poly	2.40E+03	7.00E+02	3.429	1	70.000	1.232
RH9L	glassware	Glass	2.40E+03	6.50E+02	3.692	1	71.818	1.306
RH9LL	bulb	Glass	6.40E+03	1.60E+03	4.000	1	73.636	1.386
LN-44	bottle	Glass	1.60E+04	3.90E+03	4.103	1	75.455	1.412
RH9H	bottle	Glass	3.60E+03	5.00E+02	7.200	1	77.273	1.974
LN-25	bottle	Glass	8.80E+03	1.10E+03	8.000	1	79.091	2.079
LN-6	tool	Metal	4.10E+05	4.80E+04	8.542	1	80.909	2.145
RH9R	cap	Metal	4.10E+03	4.00E+02	10.250	1	82.727	2.327
RH9KK	bottle	Glass	2.00E+03	1.80E+02	11.111	1	84.545	2.408
RH9Q	tool	Metal	3.80E+03	3.10E+02	12.258	1	86.364	2.506
RH9O	bottle	Glass	1.30E+03	9.90E+01	13.131	1	88.182	2.575
RH9QQ	bottle	Poly	1.90E+04	1.30E+03	14.615	1	90.000	2.682
RH9U	Lid	Poly	2.20E+03	1.40E+02	15.714	1	91.818	2.755
RH9V	Valve	Poly	1.60E+04	8.50E+02	18.824	1	93.636	2.935
RH9G	bottle	Glass	3.70E+03	1.70E+02	21.765	1	95.455	3.080
RH9T	Wire	Metal	1.60E+03	6.30E+01	25.397	1	97.273	3.235
LN-15	bottles	Glass	5.00E+05	[illegible]00E+03	500.000	1	99.091	6.215

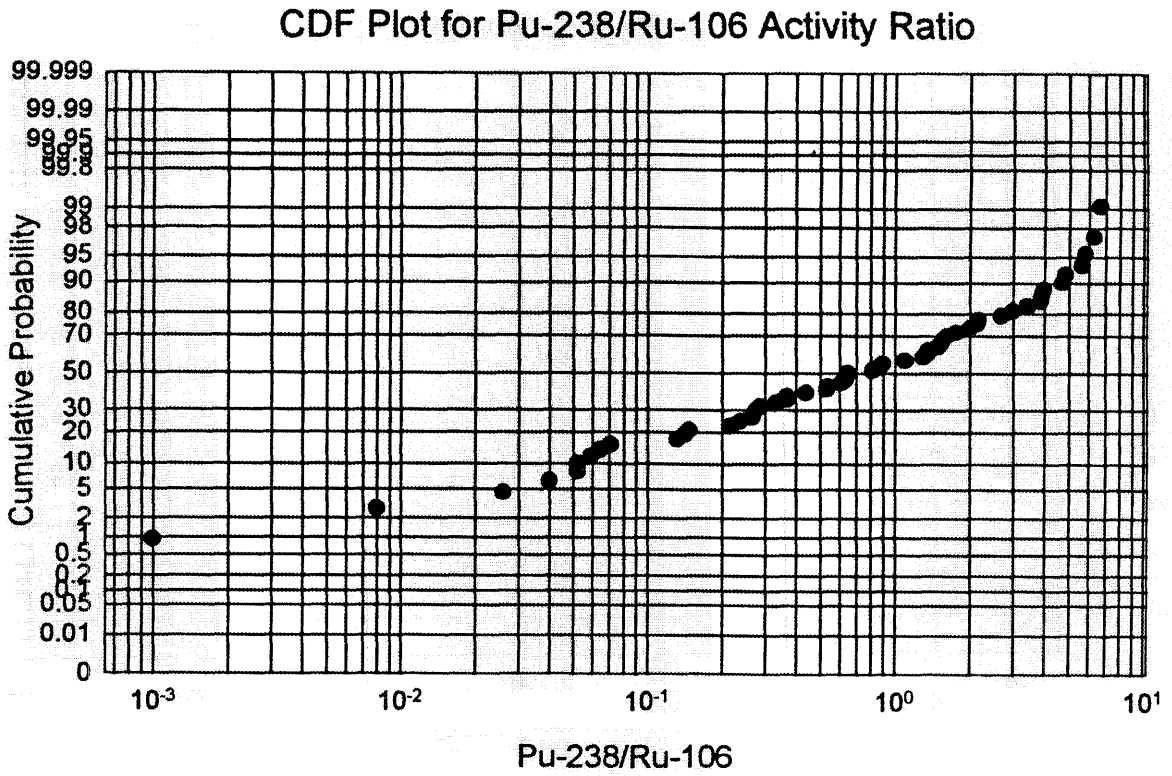
Cm246/Cs137

Sample ID	Waste Component	Waste Group	Cm246 (Bq/total)	Cs137 (Bq/total)	Cm246/Cs137 X(a,g)	Frequency	Cummulative Probability	Ln [X(a,g)]
RH9LL	bottle	Glass	1.20E+02	1.60E+03	0.075	1	0.909	-2.590
LN-46	can	Metal	3.80E+02	2.20E+03	0.173	1	2.727	-1.756
LN-GL	bottles	Glass	1.20E+06	6.70E+06	0.179	1	4.545	-1.720
RH9V	Wipes	Wipes	1.80E+02	8.50E+02	0.212	1	6.364	-1.552
RH9S	Wipes	Wipes	1.50E+03	6.90E+03	0.217	1	8.182	-1.526
RH9K	Lid	Poly	3.30E+02	1.40E+03	0.236	1	10.000	-1.445
LN-11	bottle	Glass	1.10E+04	4.50E+04	0.244	1	11.818	-1.409
RH9J	Lid	Poly	5.20E+02	1.80E+03	0.289	1	13.636	-1.242
RH9EE	Valve	Poly	6.20E+02	1.90E+03	0.326	1	15.455	-1.120
RH9F	Valve	Poly	4.00E+02	1.20E+03	0.333	1	17.273	-1.099
RH9M	bottle	Glass	1.00E+03	2.50E+03	0.400	1	19.091	-0.916
RH9E	Valve	Poly	2.60E+02	6.20E+02	0.419	1	20.909	-0.869
LN-38	tool	Metal	8.40E+02	1.90E+03	0.442	1	22.727	-0.816
LN-6	bottle	Glass	2.30E+04	4.80E+04	0.479	1	24.545	-0.736
RH9O	housing	Glass	5.25E+01	9.90E+01	0.530	1	26.364	-0.634
RH9R	Lid	Metal	2.15E+02	4.00E+02	0.538	1	28.182	-0.621
LN-1	bottle	Glass	1.10E+04	2.00E+04	0.550	1	30.000	-0.598
RH9A	Melt	Poly	1.10E+02	1.90E+02	0.579	1	31.818	-0.547
LN-54	case	Metal	1.80E+03	3.00E+03	0.600	1	33.636	-0.511
RH9I	MSM Boot	Poly	6.30E+02	9.90E+02	0.636	1	35.455	-0.452
LN-41	column	Metal	4.80E+03	6.30E+03	0.762	1	37.273	-0.272
RH9P	Tool	Metal	9.90E+02	1.20E+03	0.825	1	39.091	-0.192
LN-48	tool	Metal	3.90E+03	4.60E+03	0.848	1	40.909	-0.165
RH9D	bckt	Poly	4.85E+02	5.70E+02	0.851	1	42.727	-0.161
LN-40	hose	Poly	1.45E+04	1.70E+04	0.853	1	44.545	-0.159
RH9SS	Wipes	Wipes	6.10E+02	7.00E+02	0.871	1	46.364	-0.138
LN-44	cap	Metal	3.50E+03	3.90E+03	0.897	1	48.182	-0.108
RH9L	bottle	Glass	6.00E+02	6.50E+02	0.923	1	50.000	-0.080
RH9AA	Melt	Poly	9.10E+01	9.80E+01	0.929	1	51.818	-0.074
RH9C	Melt	Poly	3.50E+02	3.70E+02	0.946	1	53.636	-0.056
RH9H	Light Cord	Poly	5.15E+02	5.00E+02	1.030	1	55.455	0.030
RH9U	Wipes	Wipes	1.55E+02	1.40E+02	1.107	1	57.273	0.102
RH9N	glassware	Glass	1.95E+03	1.50E+03	1.300	1	59.091	0.262
LN-49	socket	Metal	1.20E+03	8.70E+02	1.379	1	60.909	0.322
LN-8	bottle	Glass	1.60E+04	1.10E+04	1.455	1	62.727	0.375
RH9QQ	Wire	Metal	1.95E+03	1.30E+03	1.500	1	64.545	0.405
LN-28	bottle	Glass	1.10E+04	6.90E+03	1.594	1	66.364	0.466
RH9G	Valve	Poly	2.90E+02	1.70E+02	1.706	1	68.182	0.534
LN-33	valve	Poly	1.40E+04	7.80E+03	1.795	1	70.000	0.585
LN-19	bottle	Glass	9.05E+03	4.60E+03	1.967	1	71.818	0.677
LN-25	bottle	Glass	2.70E+03	1.10E+03	2.455	1	73.636	0.898
RH9T	Wipes	Wipes	1.60E+02	6.30E+01	2.540	1	75.455	0.932
LN-7	tool	Metal	2.10E+03	8.20E+02	2.561	1	77.273	0.940
LN-13	bottle	Glass	2.30E+04	8.60E+03	2.674	1	79.091	0.984
RH9Q	Wire	Metal	8.75E+02	3.10E+02	2.823	1	80.909	1.038
RH9KK	Lid	Poly	5.75E+02	1.80E+02	3.194	1	82.727	1.161
LN-3	bottle	Glass	2.85E+04	8.80E+03	3.239	1	84.545	1.175
LN-15	tool	Metal	3.30E+03	1.00E+03	3.300	1	86.364	1.194
LN-4	bottle	Glass	1.30E+04	3.60E+03	3.611	1	88.182	1.284
LN-9	bulb	Glass	2.05E+04	5.20E+03	3.942	1	90.000	1.372
LN-35	bottle	Poly	1.50E+04	3.80E+03	3.947	1	91.818	1.373
LN-26	bottle	Glass	1.45E+04	3.50E+03	4.143	1	93.636	1.421
LN-36	cell	Metal	2.90E+04	6.30E+03	4.603	1	95.455	1.527
LN-ML	tool	Metal	7.30E+05	1.50E+05	4.867	1	97.273	1.582
LN-39	cell	Metal	3.90E+04	4.40E+03	8.864	1	99.091	2.182

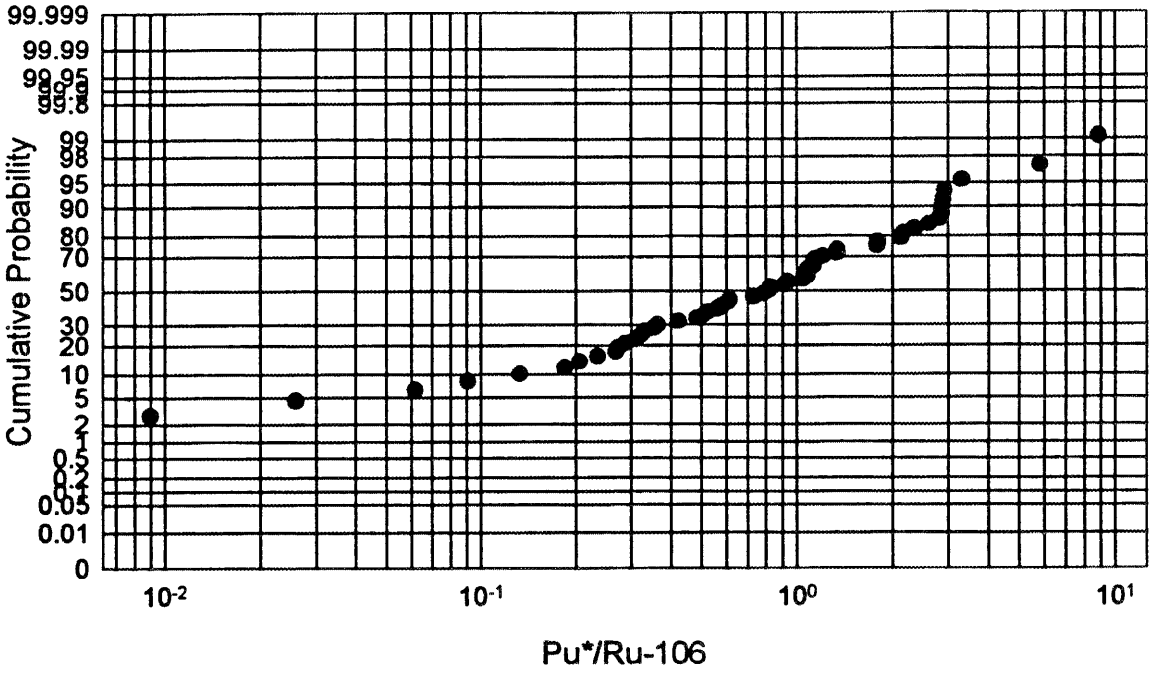
APPENDIX D

CDF plots for alpha / gamma activity ratios calculated in Appendix B

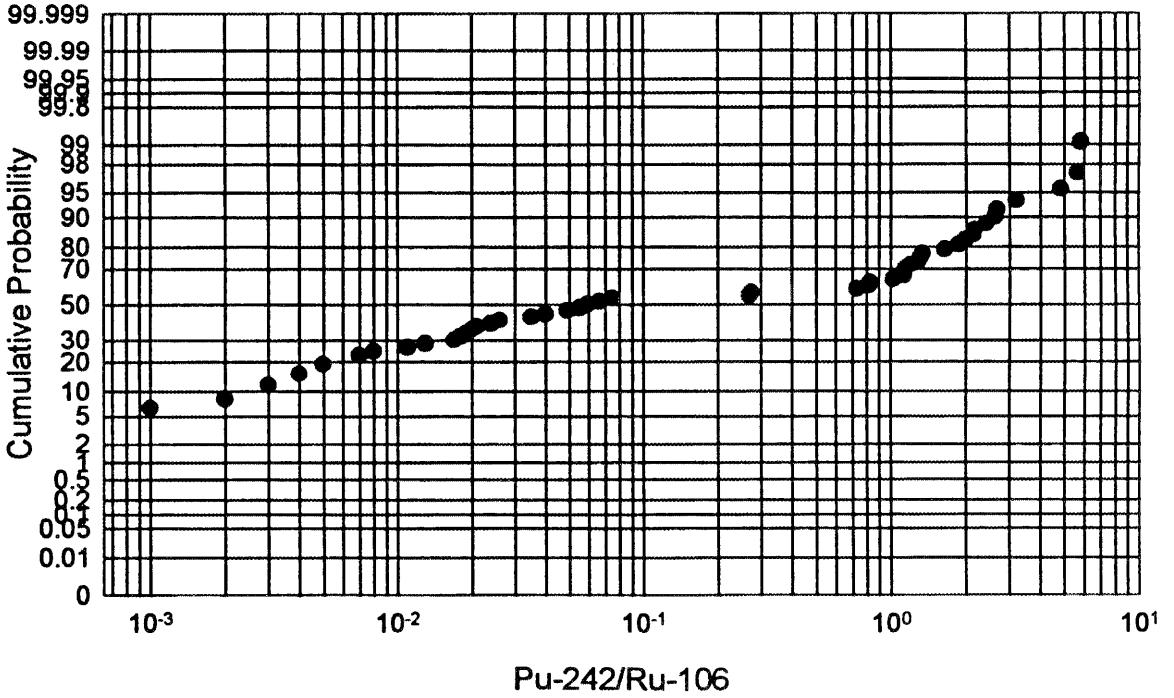

CDF Plot for Cm-244/Ru-106 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^0
10^1
10^2
10^3
10^4
Cm-244/Ru-106

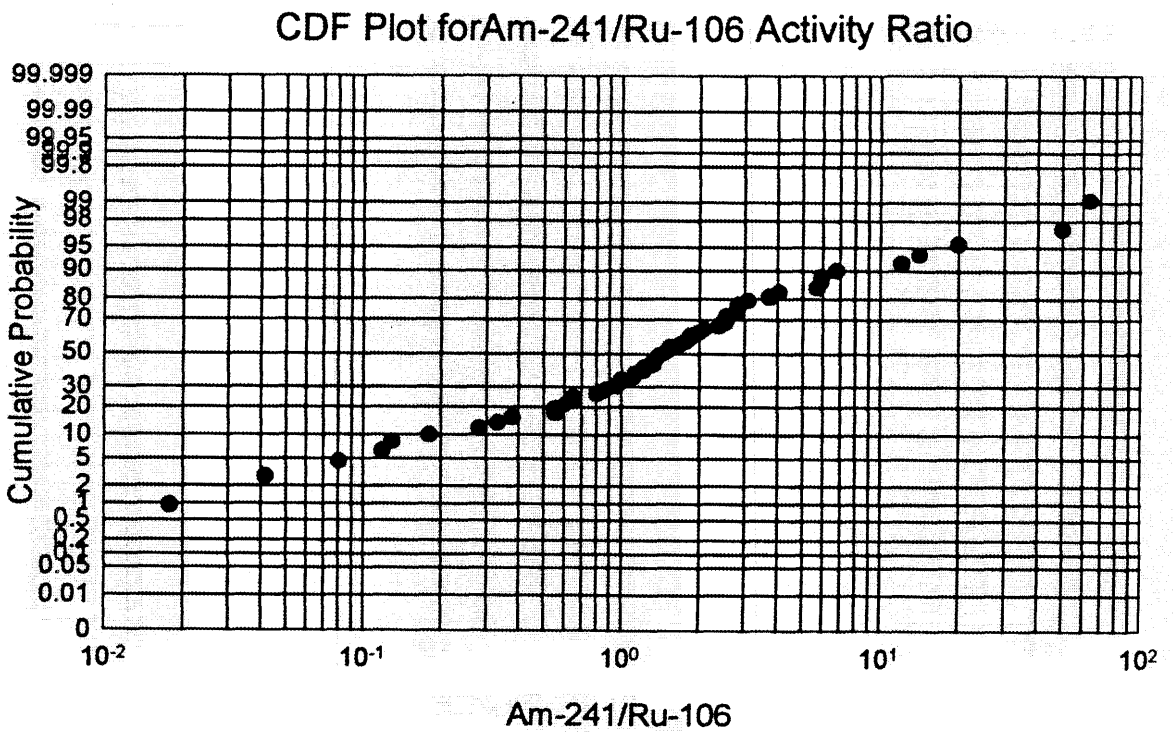

CDF Plot for Pu-238/Ru-106 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^0
10^1
Pu-238/Ru-106

CDF Plot forPu*/Ru-106 Activity Ratio



CDF Plot for Pu-242/Ru-106 Activity Ratio




CDF Plot forAm-241/Ru-106 Activity Ratio
Cumulative Probability
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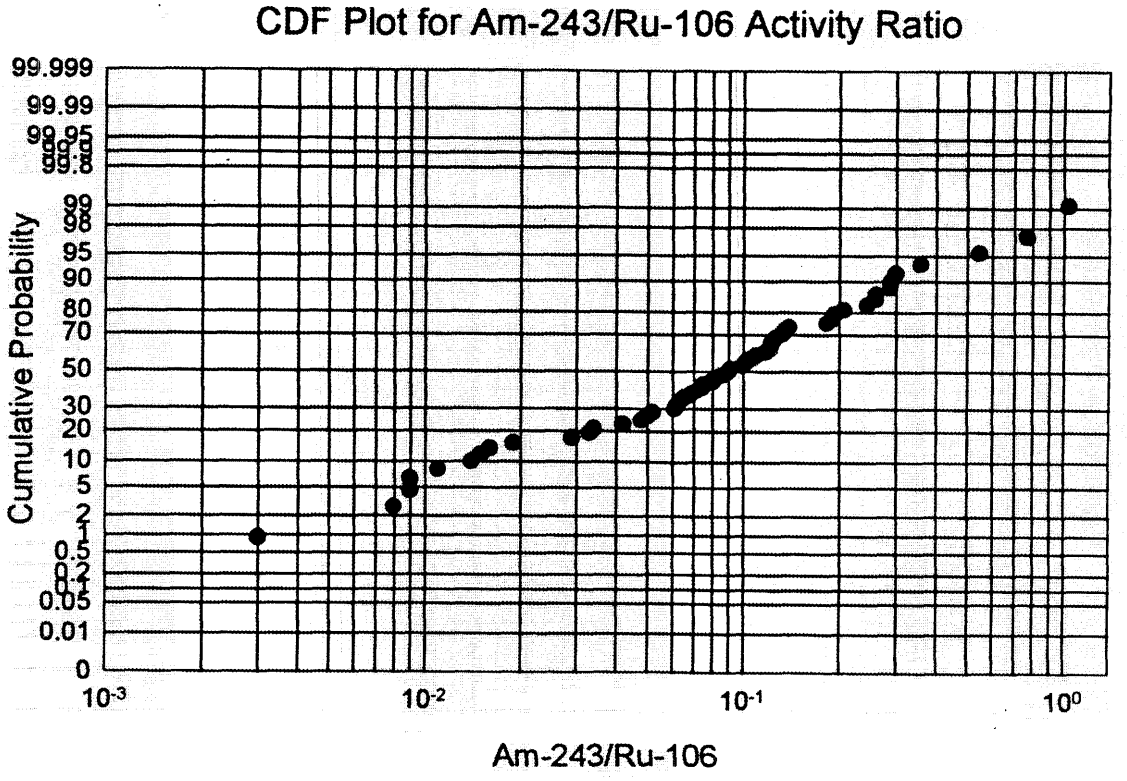
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Am-241/Ru-106


CDF Plot for Am-243/Ru-106 Activity Ratio
Cumulative Probability
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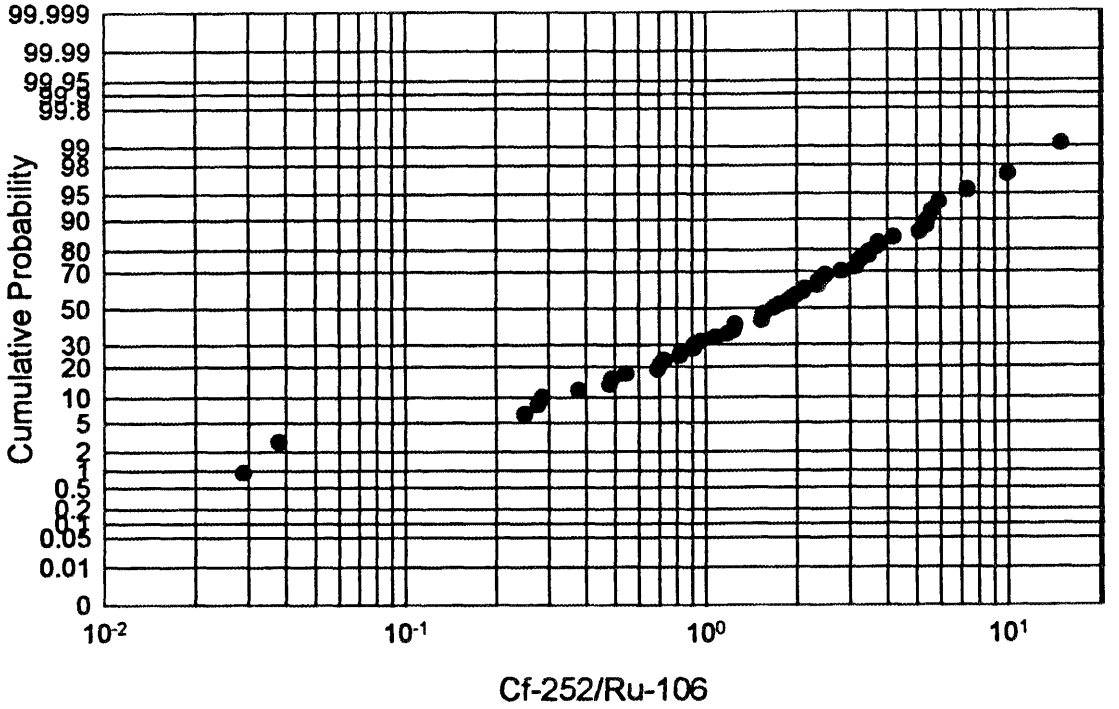
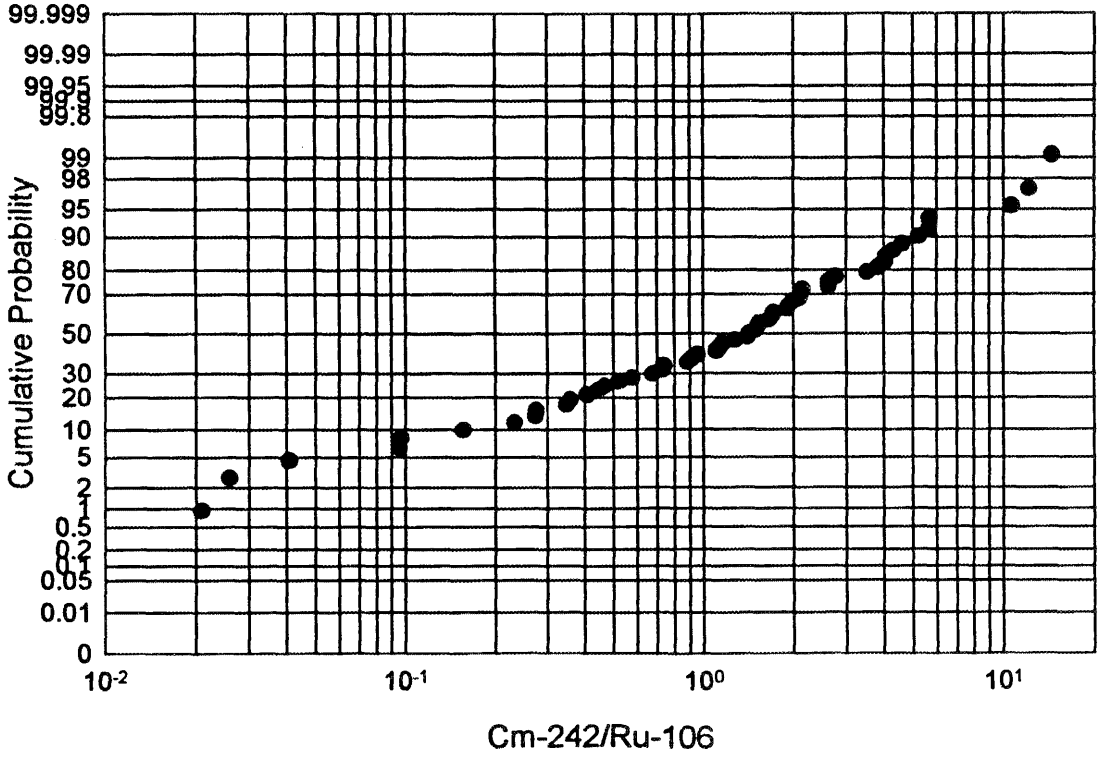
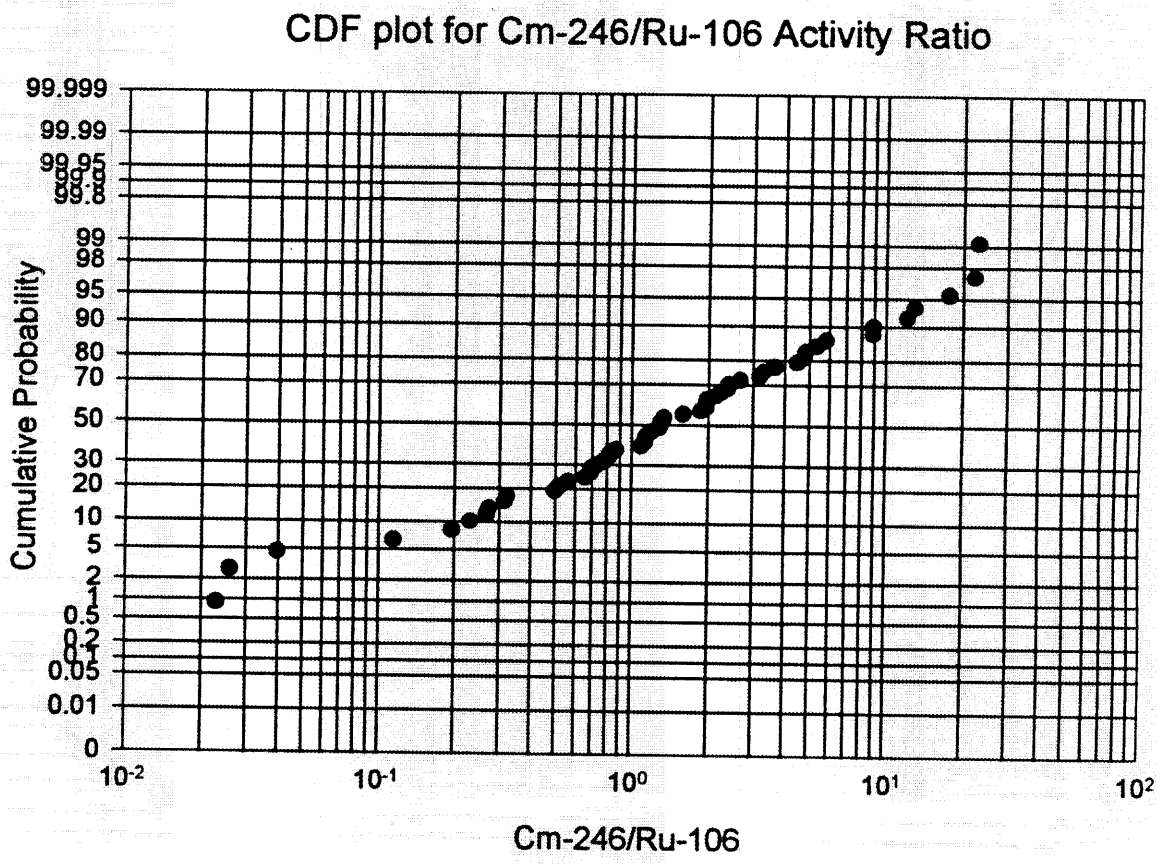
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
Am-243/Ru-106

CDF Plot forCf-252/Ru-106 Activity Ratio



CDF Plot for Cm-242/Ru-106 Activity Ratio




CDF plot for Cm-246/Ru-106 Activity Ratio
Cumulative Probability
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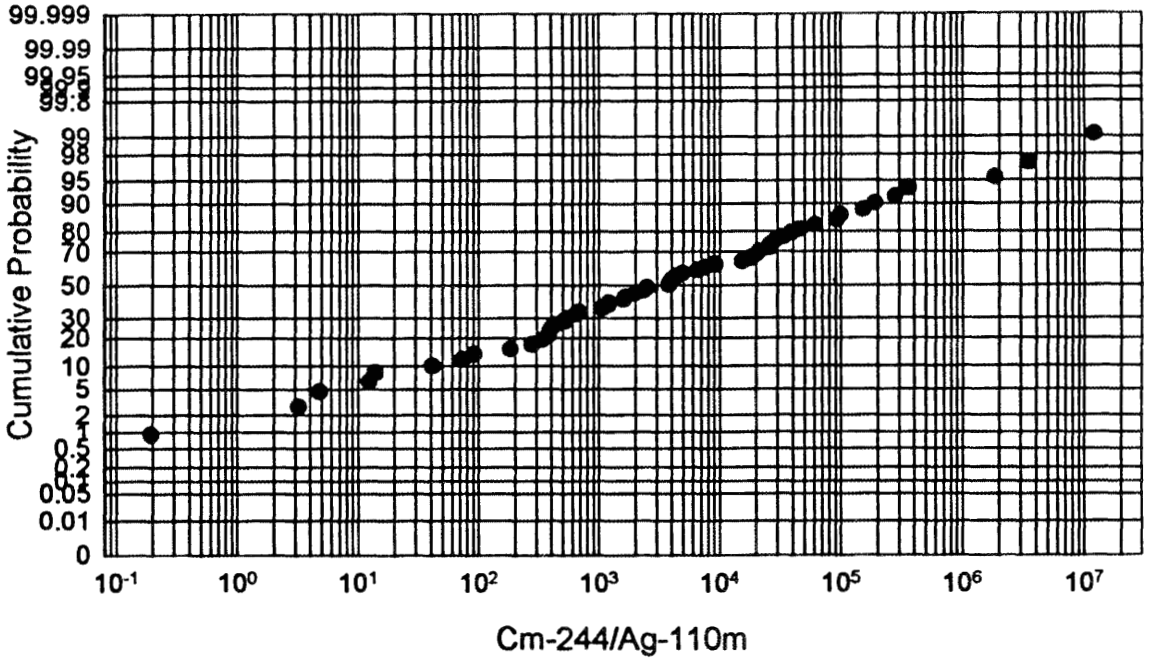
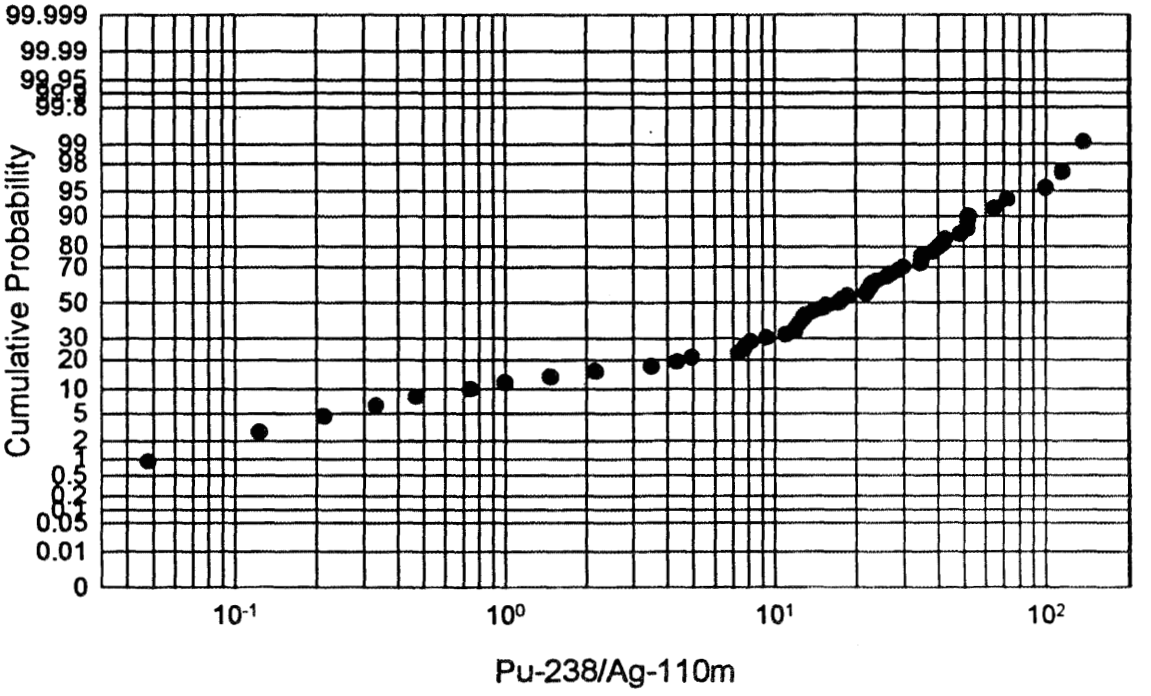
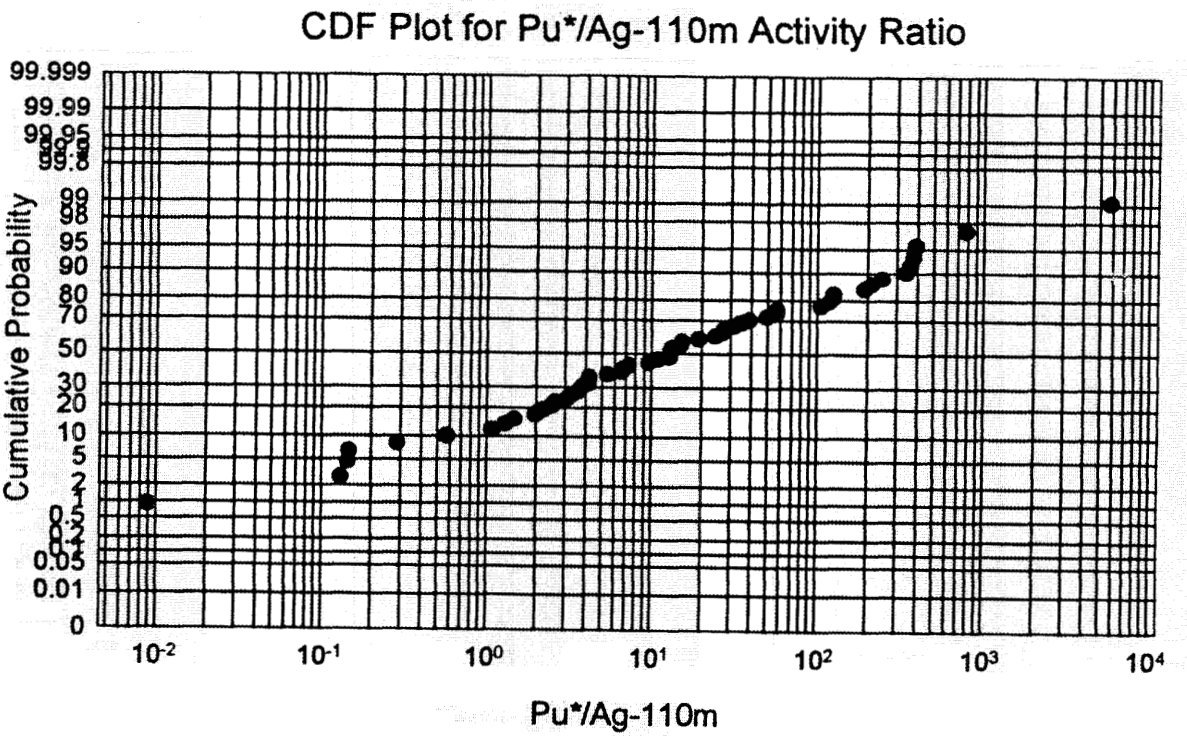
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Cm-246/Ru-106

CDF Plot for Cm-244/Ag-110m Activity Ratio



CDF Plot for Pu-238/Ag-110m Activity Ratio




CDF Plot for Pu*/Ag-110m Activity Ratio
Cumulative Probability
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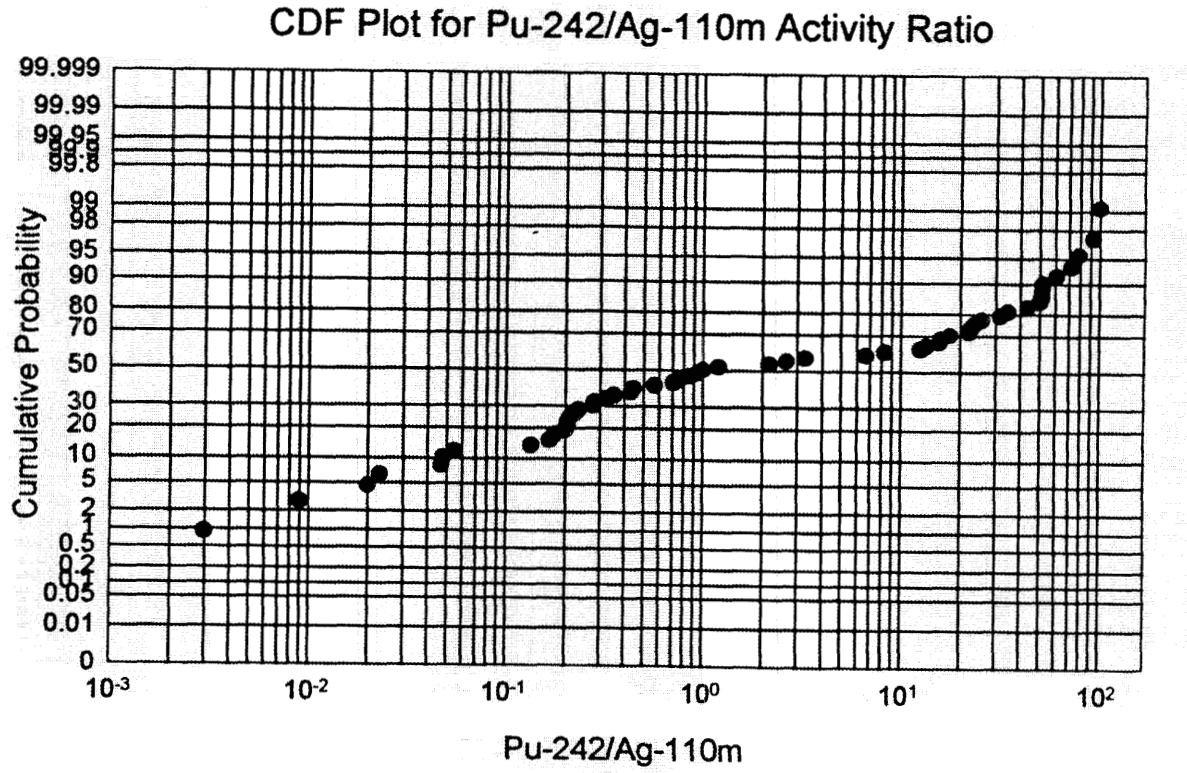
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
Pu*/Ag-110m


CDF Plot for Pu-242/Ag-110m Activity Ratio
Cumulative Probability
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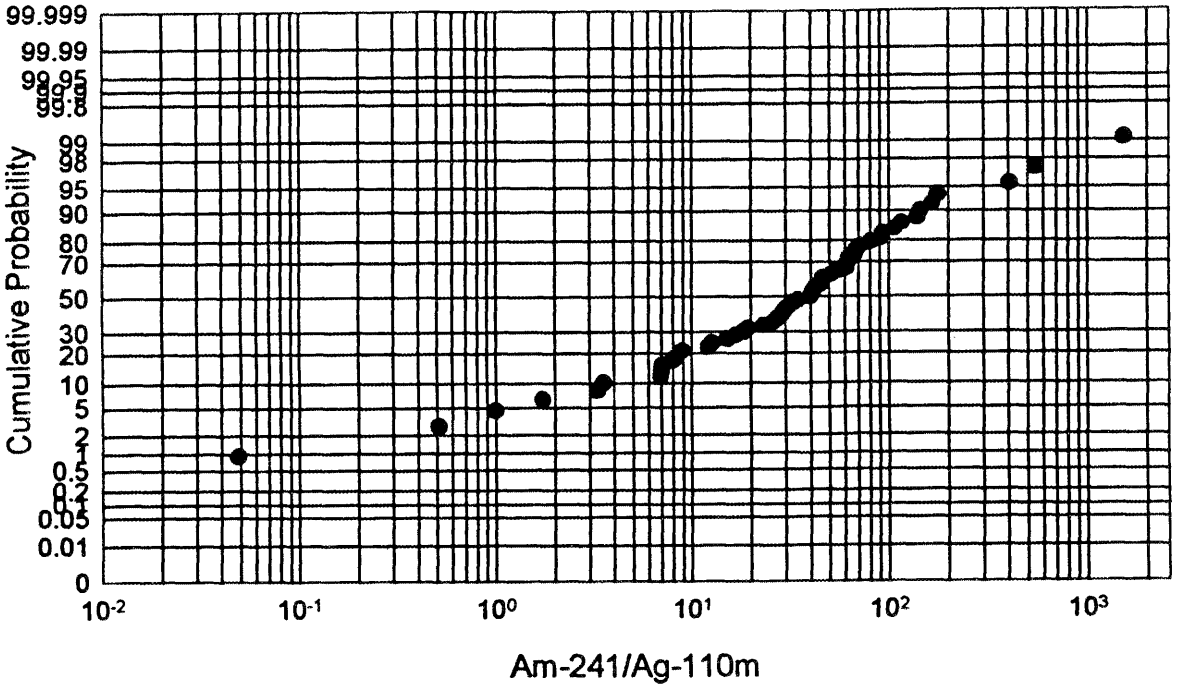
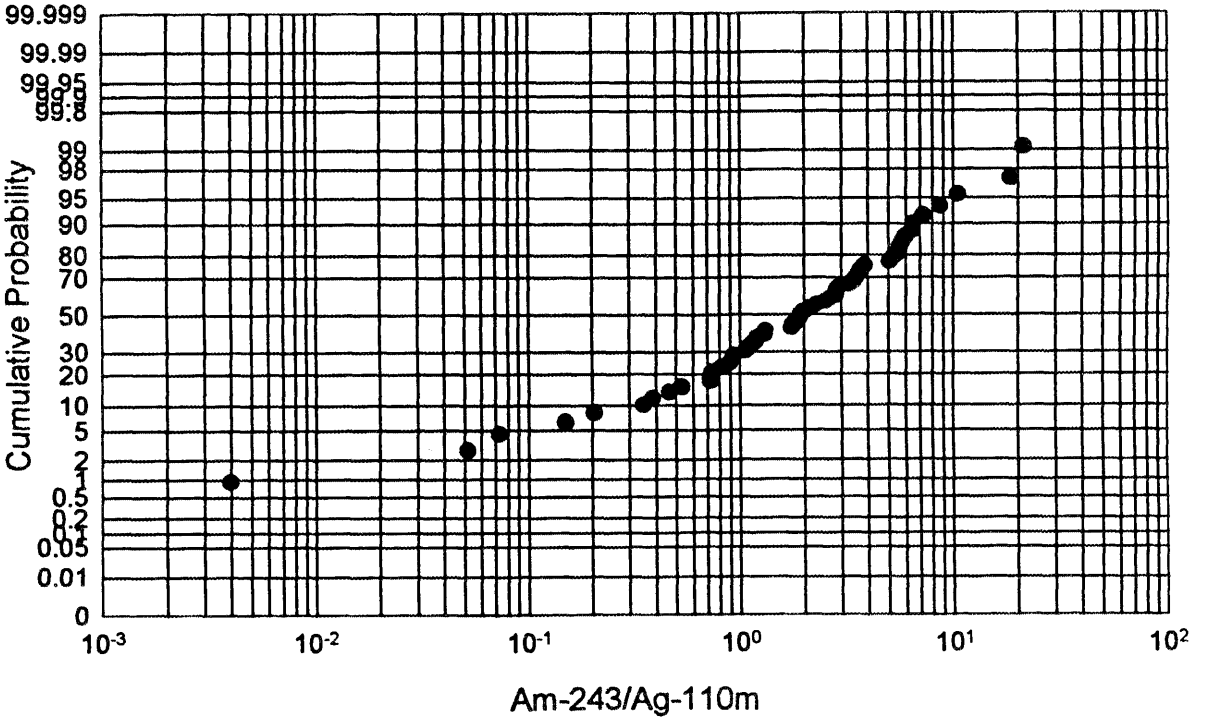
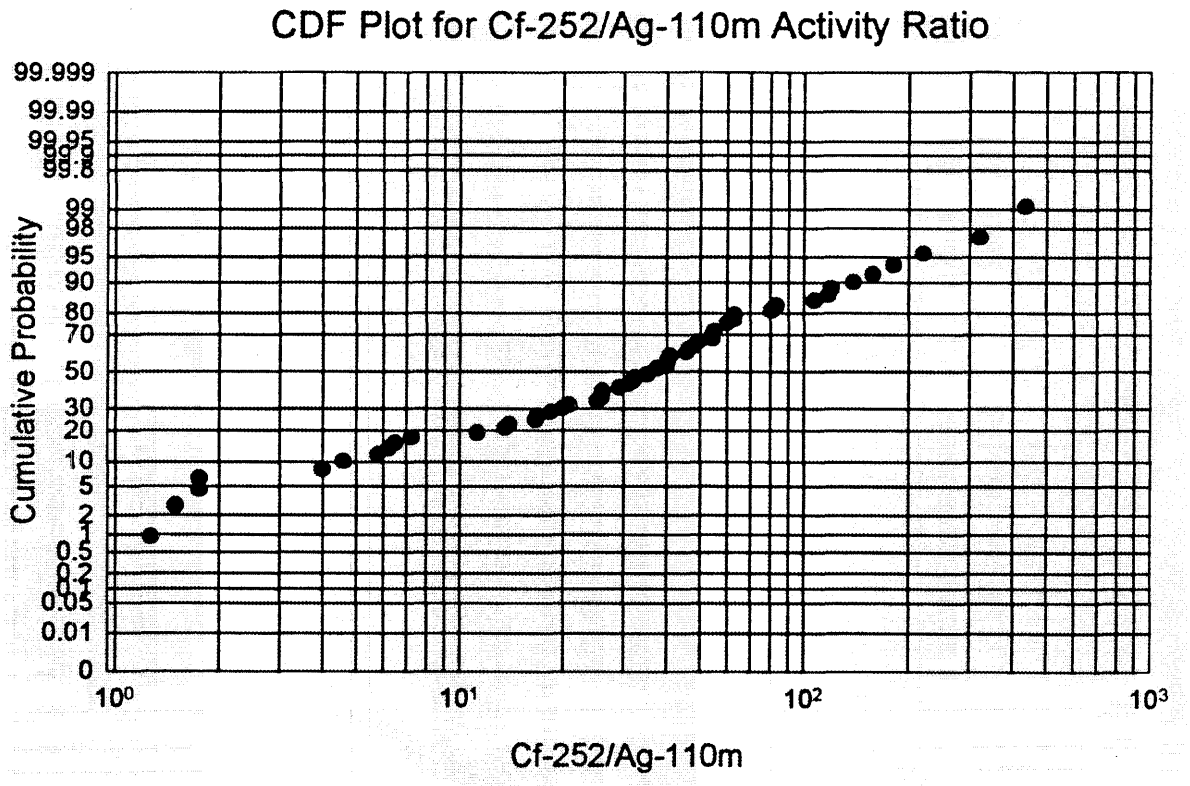
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Pu-242/Ag-110m

CDF Plot for Am-241/Ag-110m Activity Ratio



CDF Plot for Am-243/Ag-110m Activity Ratio




CDF Plot for Cf-252/Ag-110m Activity Ratio
Cumulative Probability
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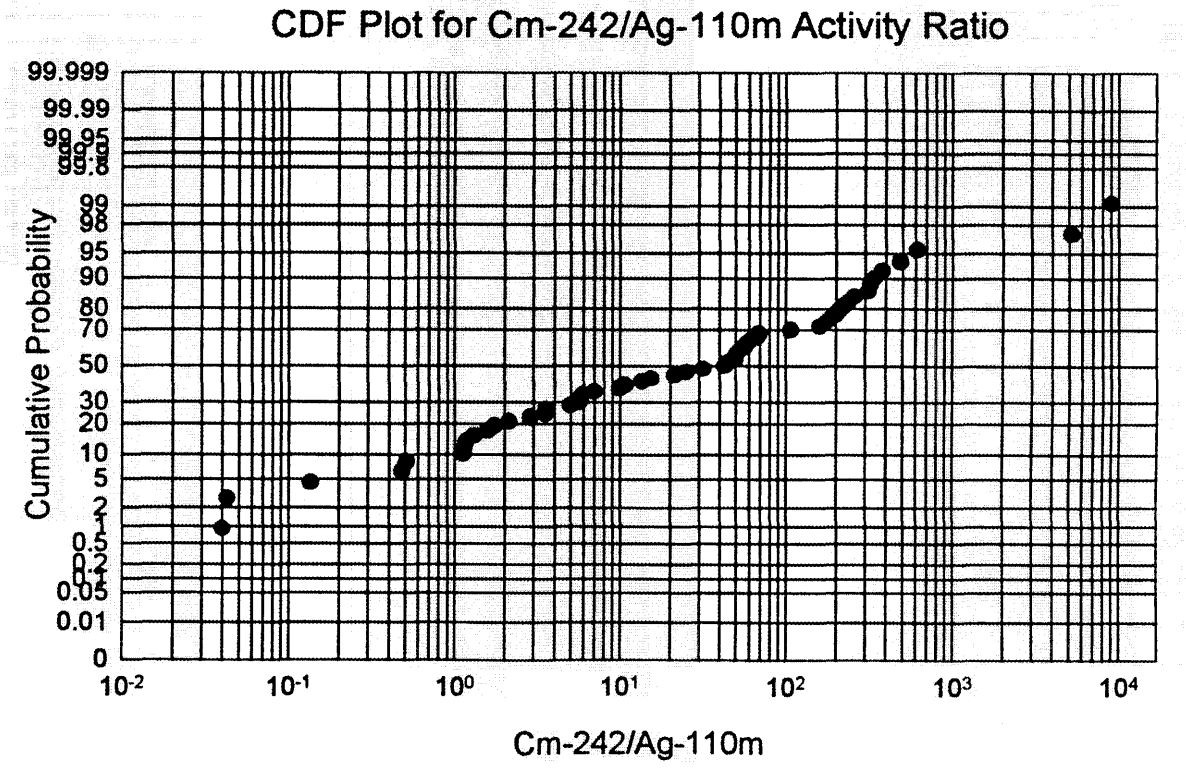
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^0
10^1
10^2
10^3
Cf-252/Ag-110m


CDF Plot for Cm-242/Ag-110m Activity Ratio
Cumulative Probability
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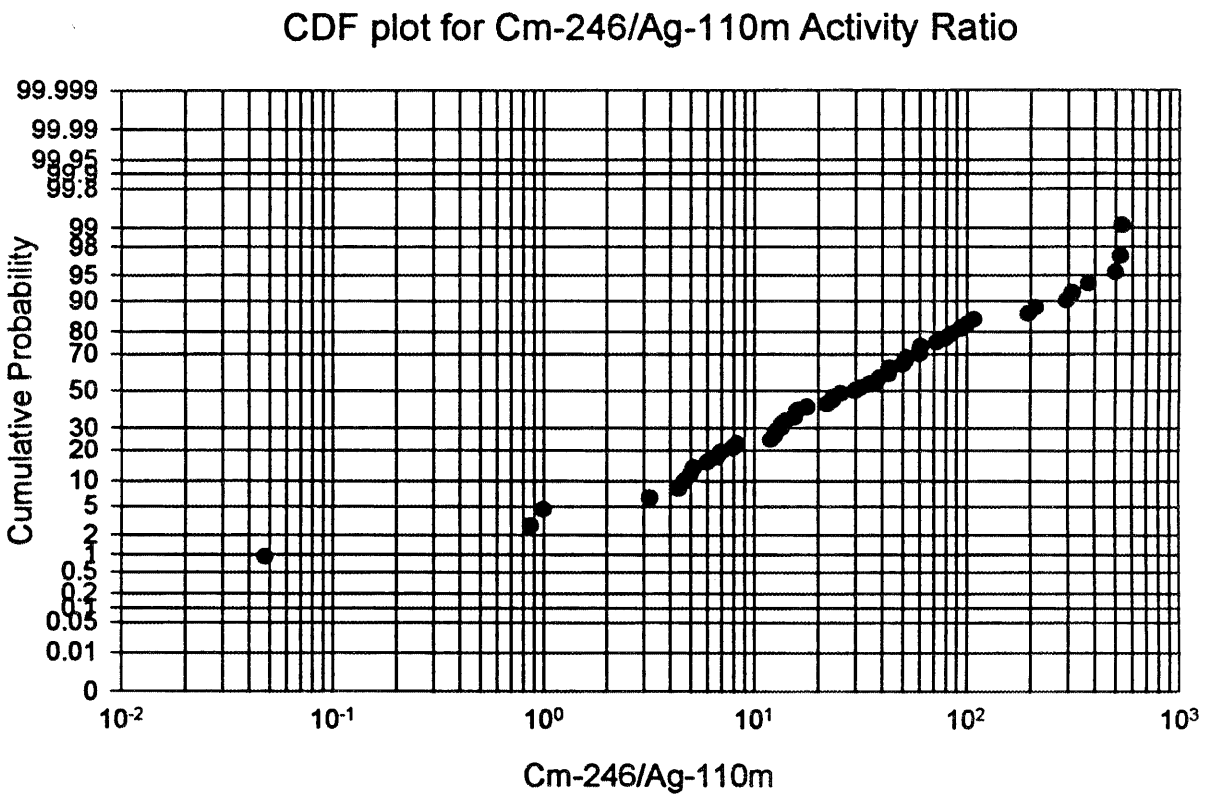
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^0
10^1
10^2
10^3
10^4
Cm-242/Ag-110m


CDF plot for Cm-246/Ag-110m Activity Ratio
Cumulative Probability
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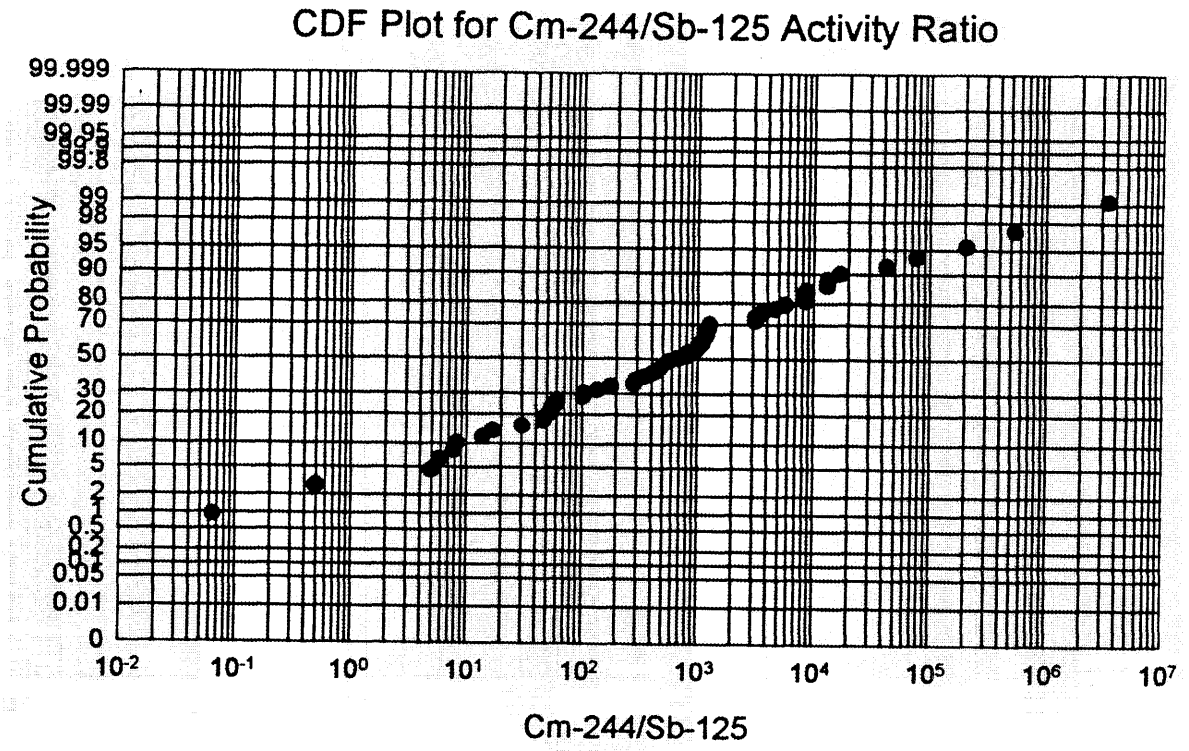
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Cm-246/Ag-110m


CDF Plot for Cm-244/Sb-125 Activity Ratio
Cumulative Probability
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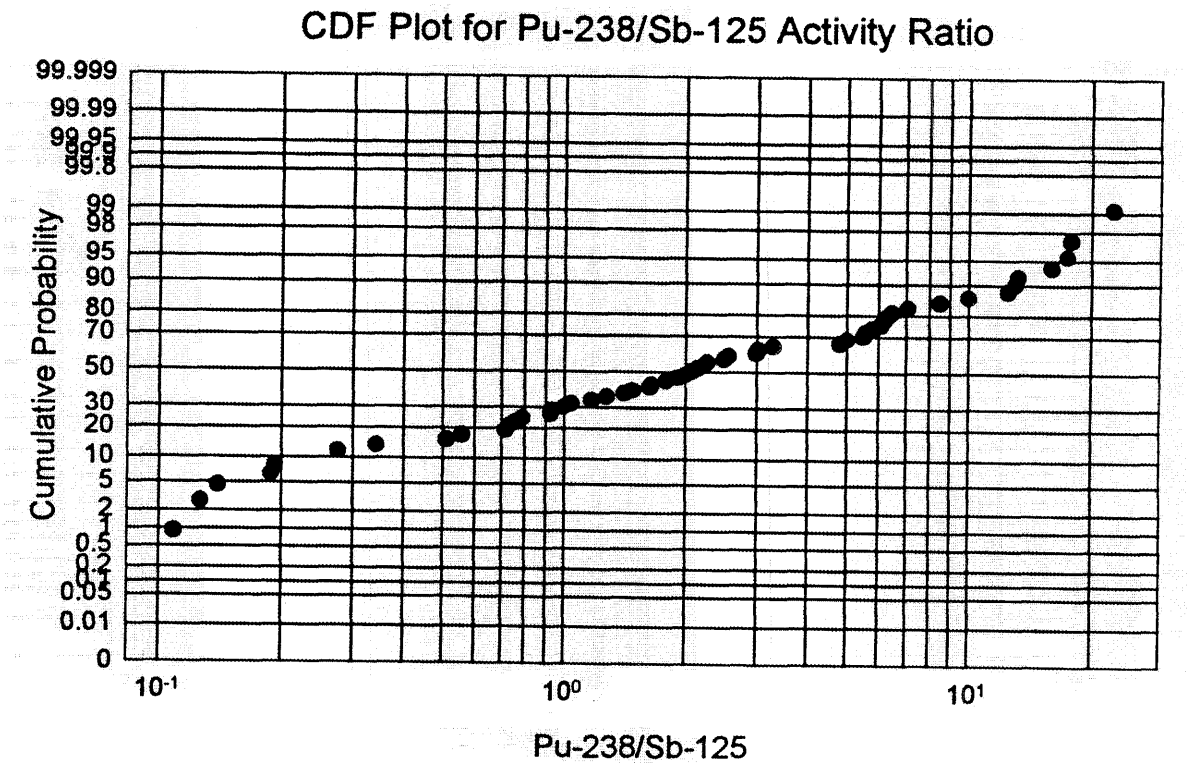
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
10^{6}
10^{7}
Cm-244/Sb-125


CDF Plot for Pu-238/Sb-125 Activity Ratio
Cumulative Probability
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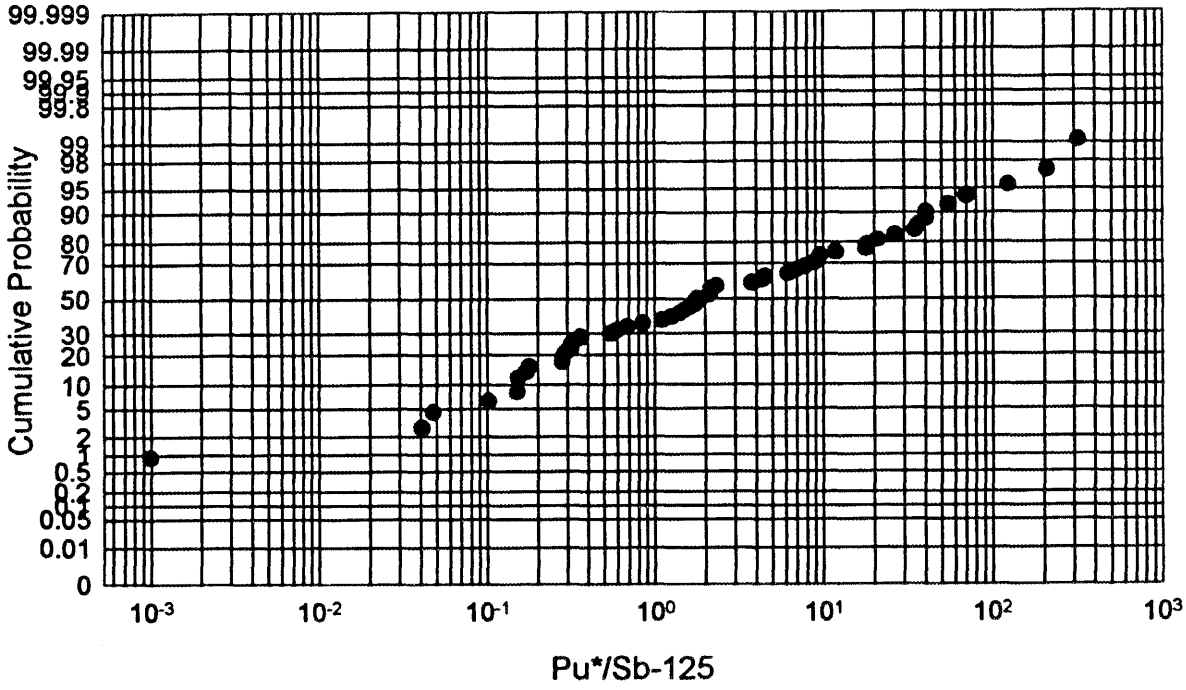
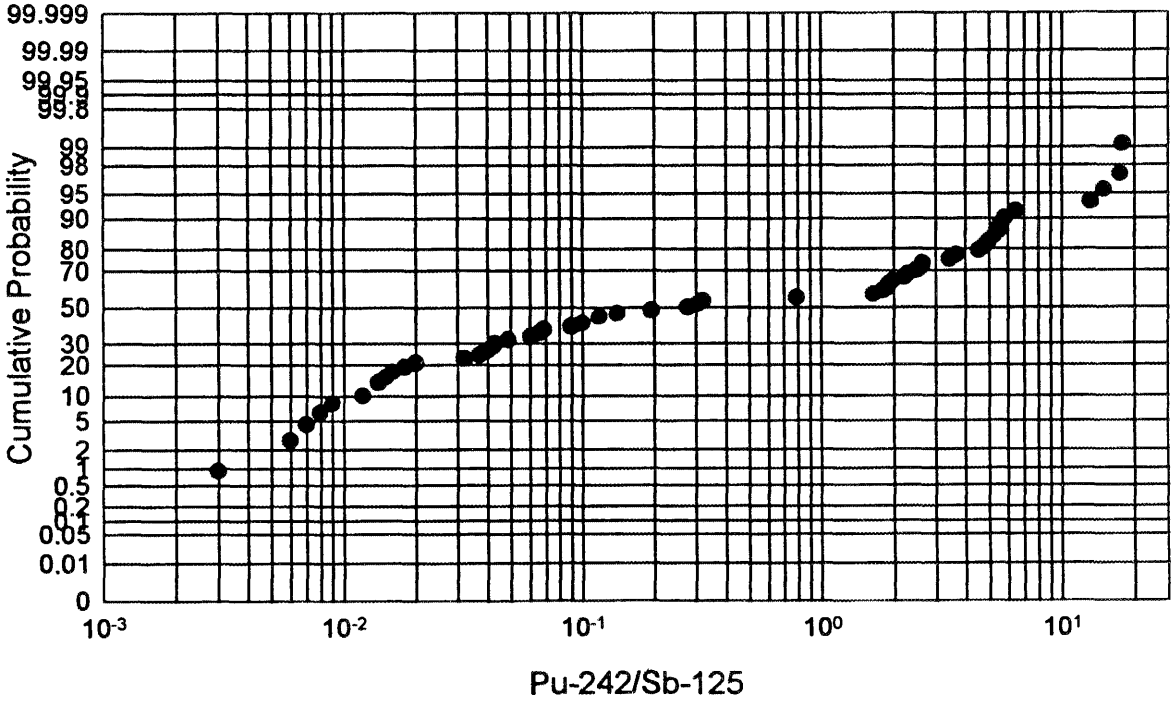
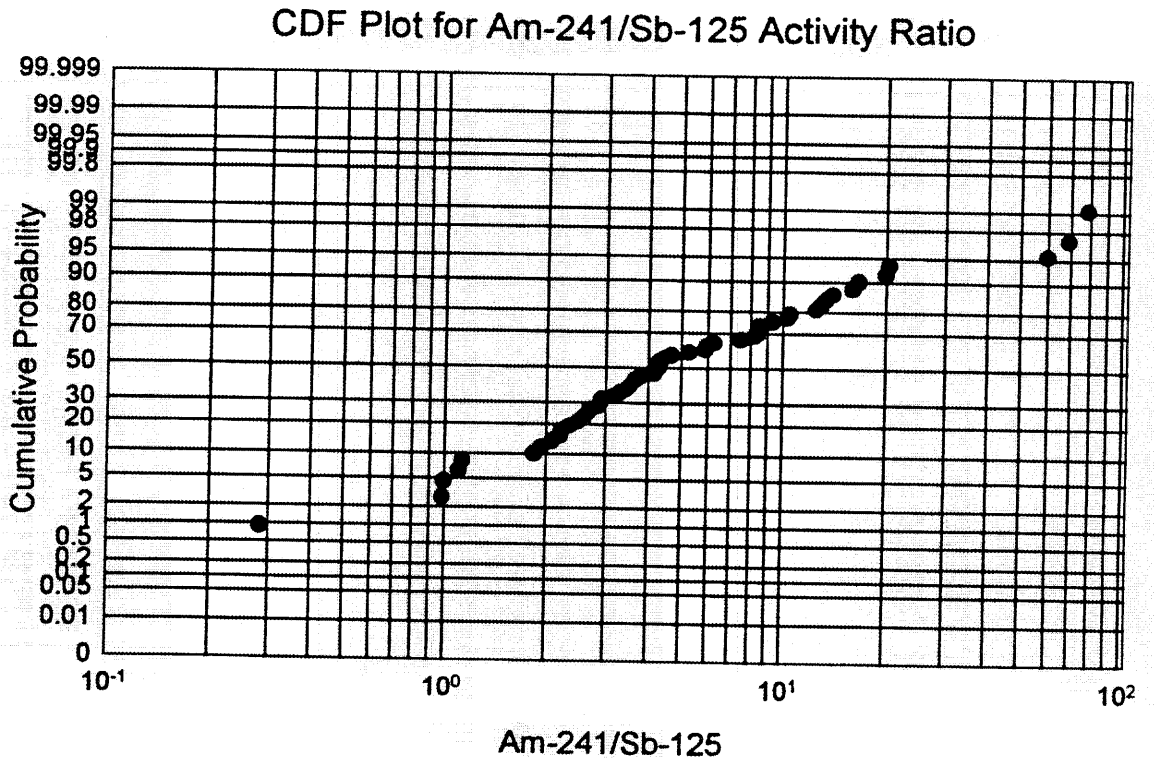
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
Pu-238/Sb-125

CDF Plot for Pu*/Sb-125 Activity Ratio



CDF Plot for Pu-242/Sb-125 Activity Ratio




CDF Plot for Am-241/Sb-125 Activity Ratio
Cumulative Probability
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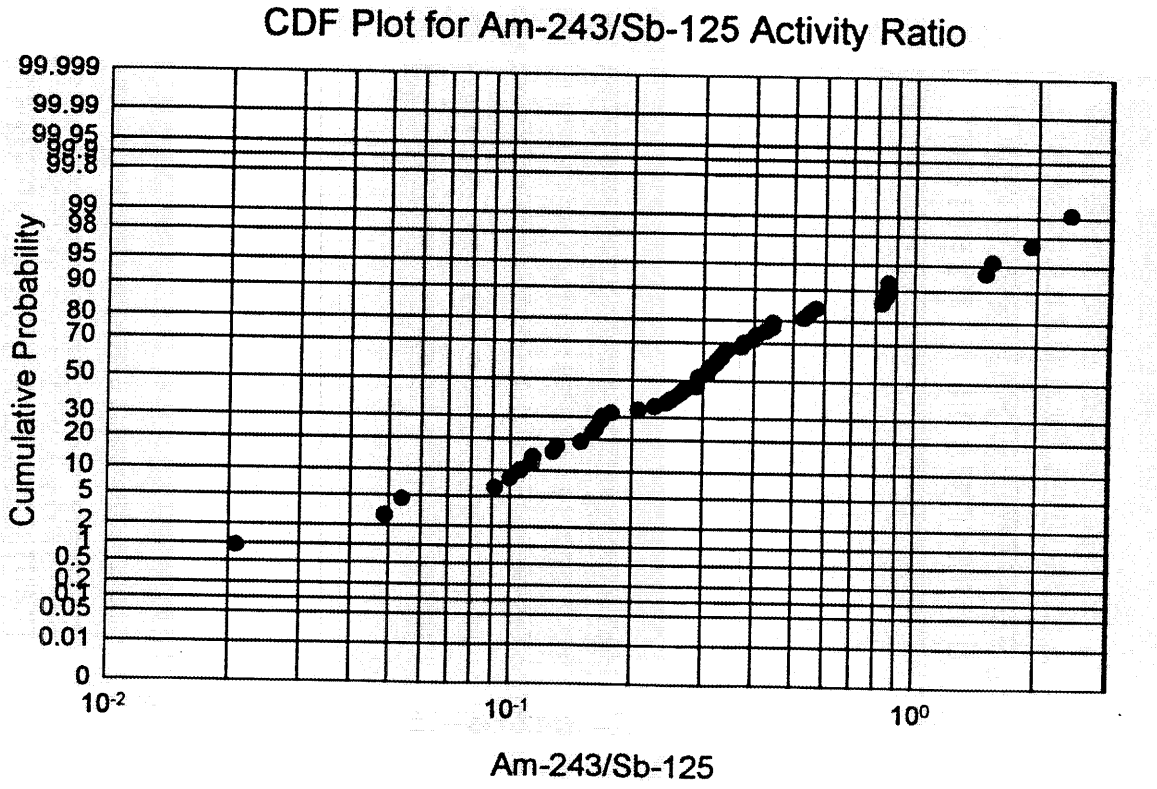
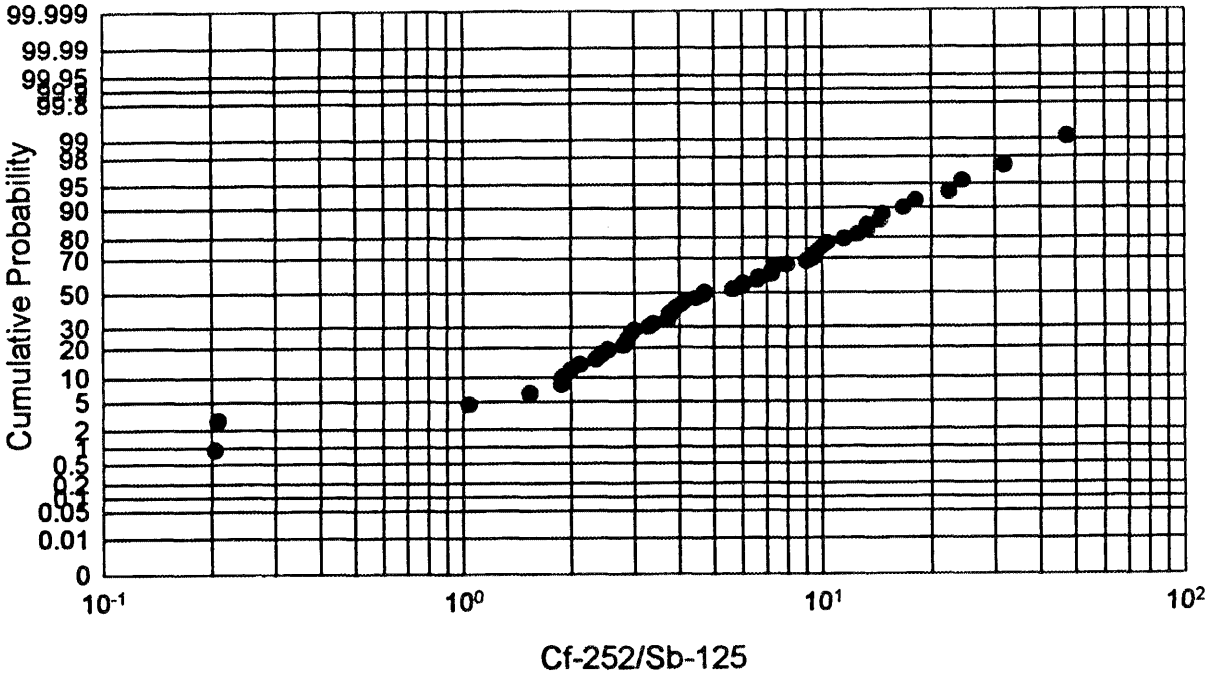
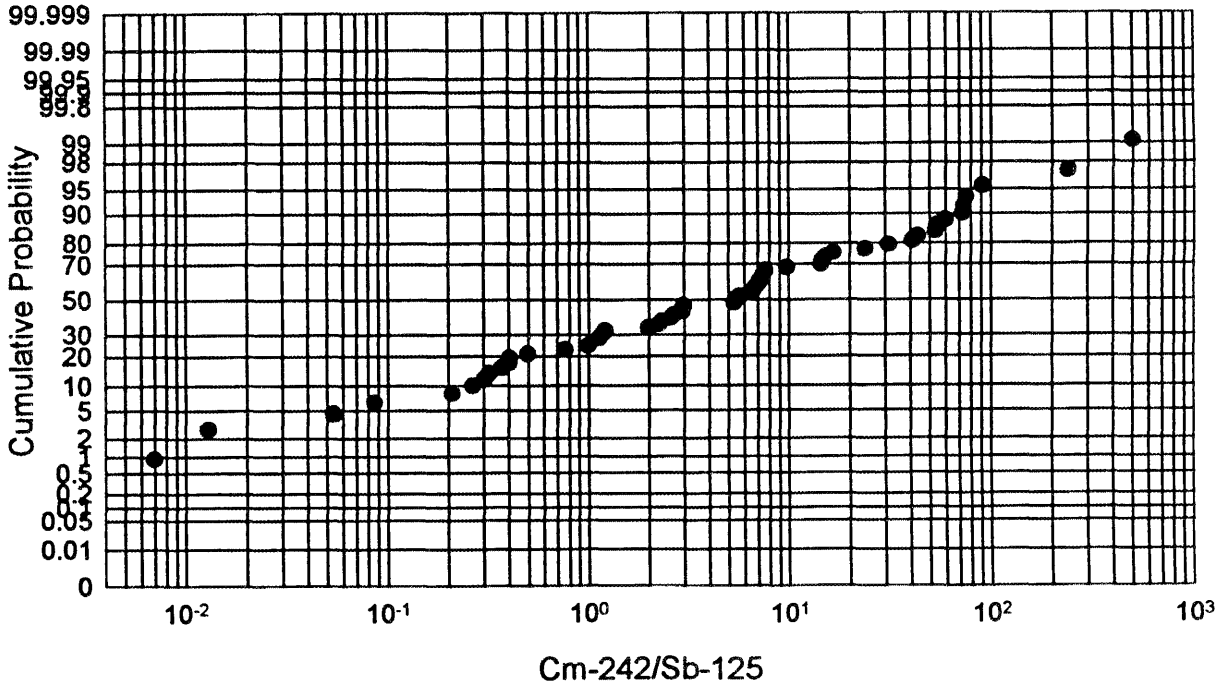
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
10^{2}
Am-241/Sb-125

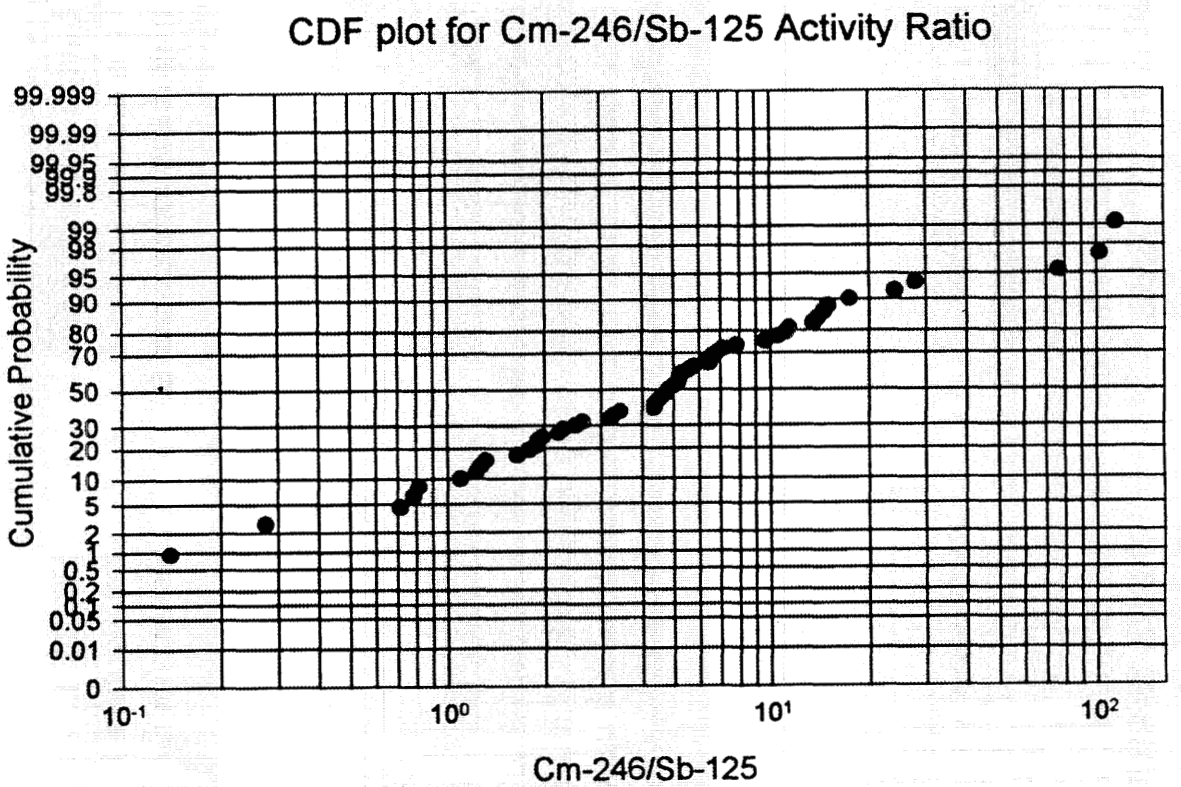

CDF Plot for Am-243/Sb-125 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
Am-243/Sb-125

CDF Plot for Cf-252/Sb-125 Activity Ratio

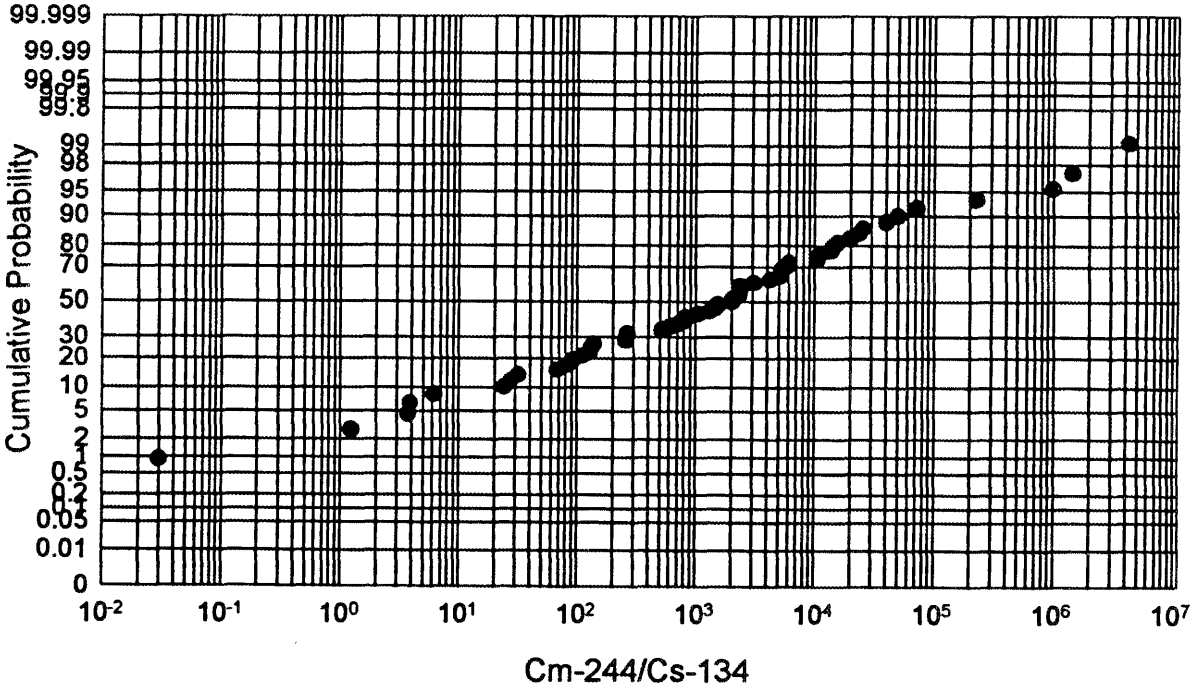


CDF Plot for Cm-242/Sb-125 Activity Ratio

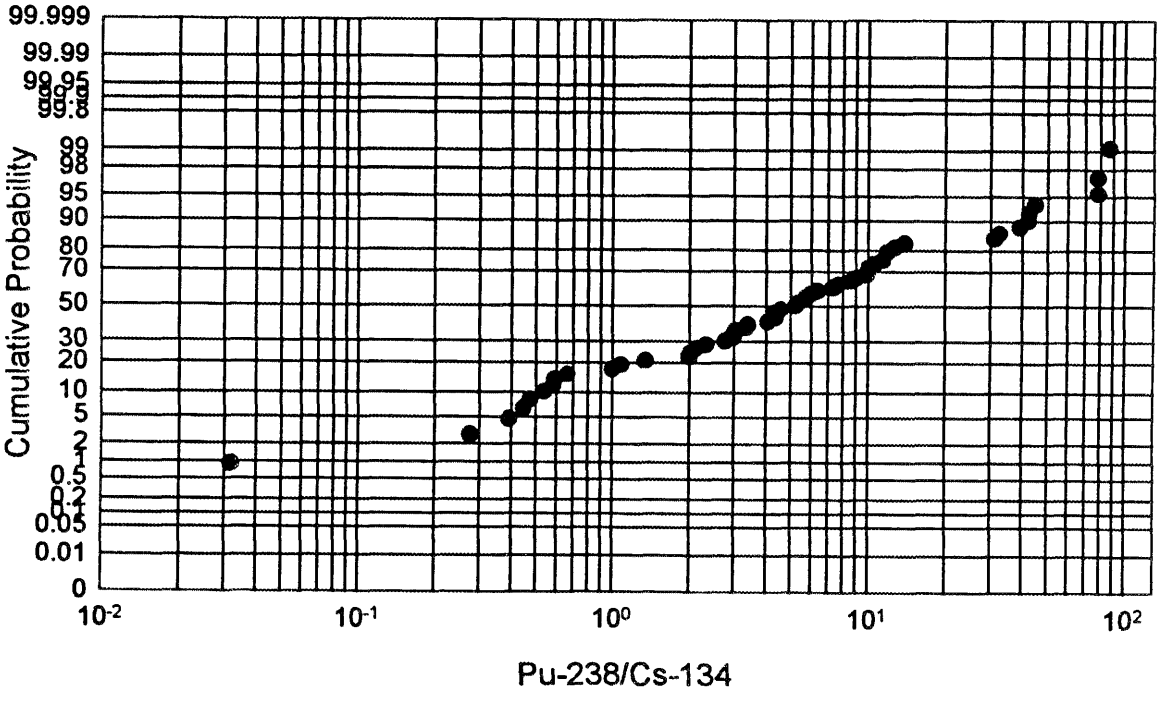


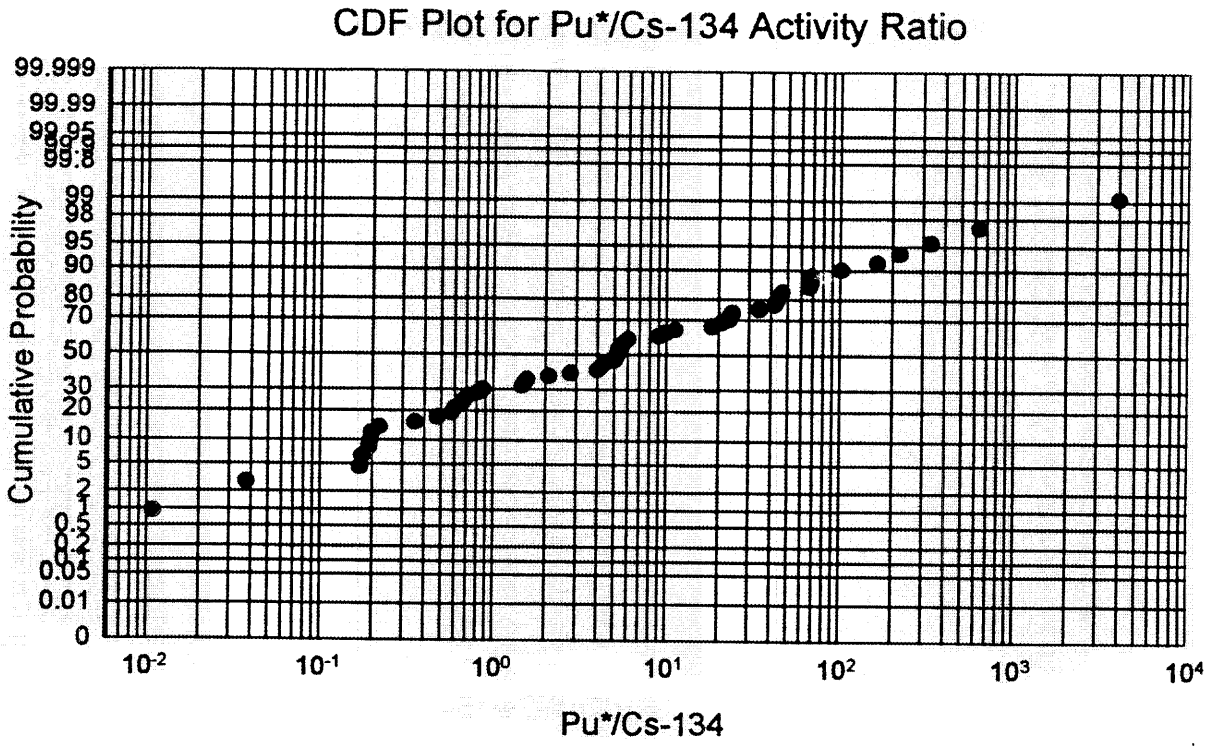

CDF plot for Cm-246/Sb-125 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
10^{2}
Cm-246/Sb-125

CDF Plot for Cm-244/Cs-134 Activity Ratio



CDF Plot for Pu-238/Cs-134 Activity Ratio




CDF Plot for Pu*/Cs-134 Activity Ratio
Cumulative Probability
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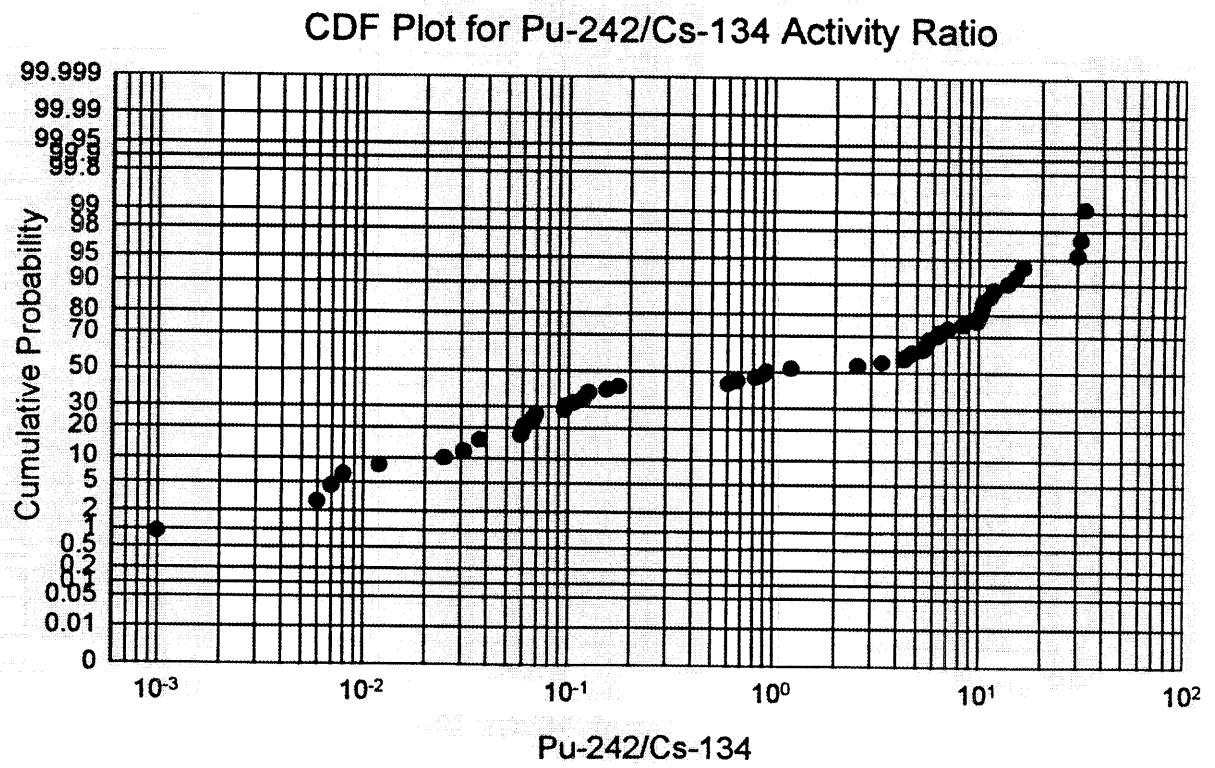
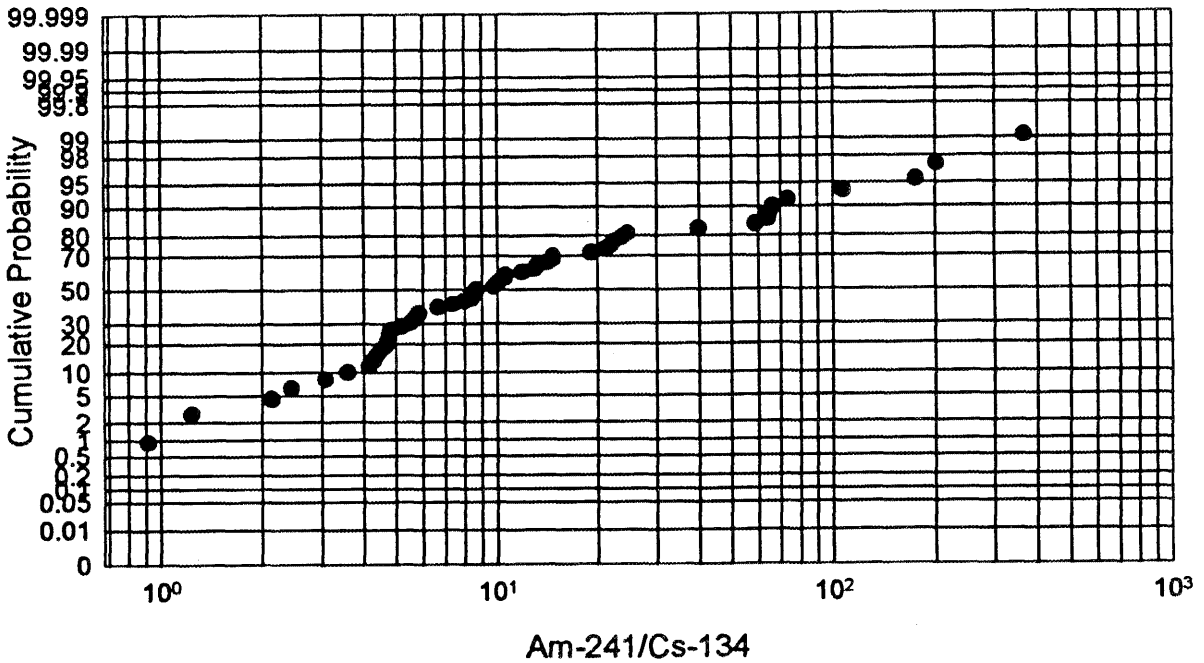
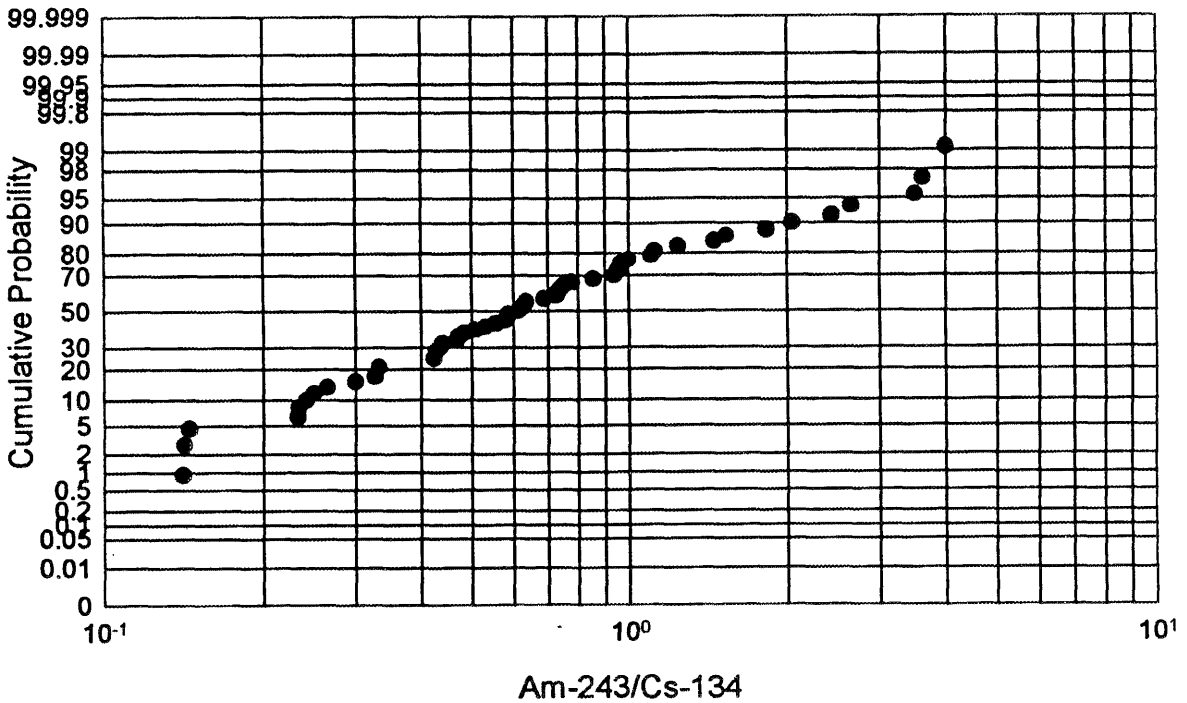
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
Pu*/Cs-134

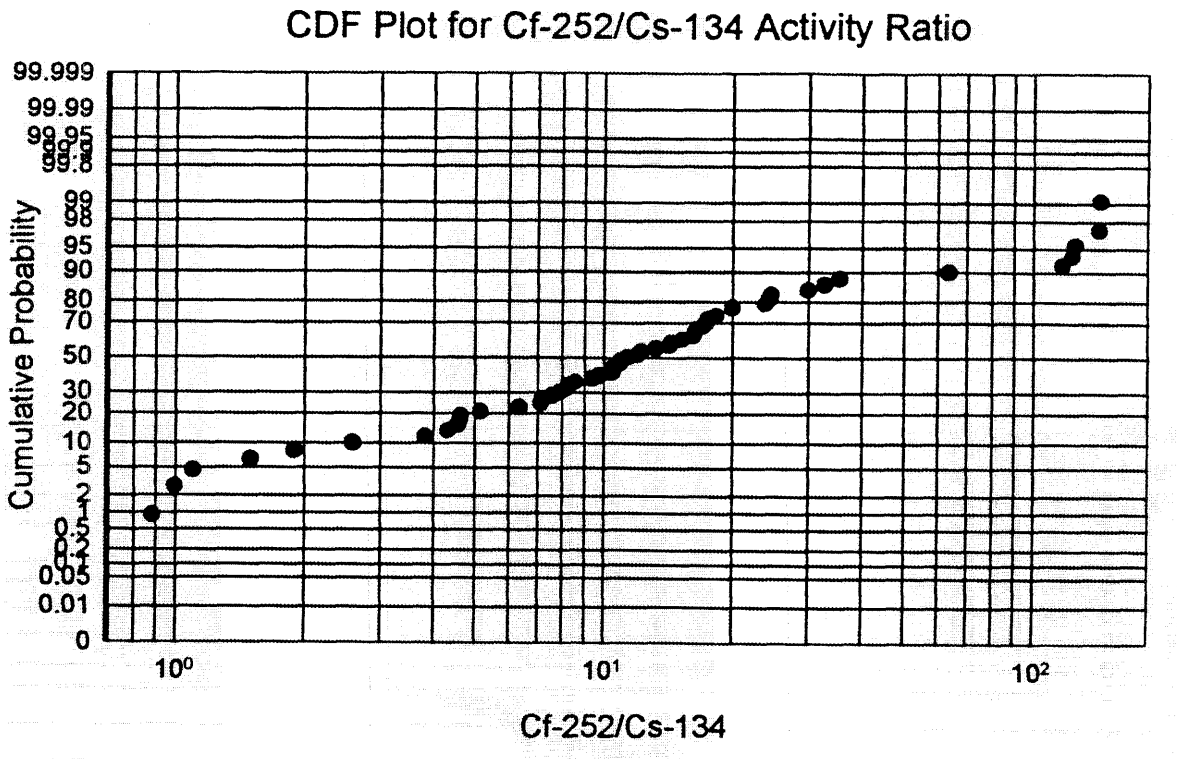

CDF Plot for Pu-242/Cs-134 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Pu-242/Cs-134

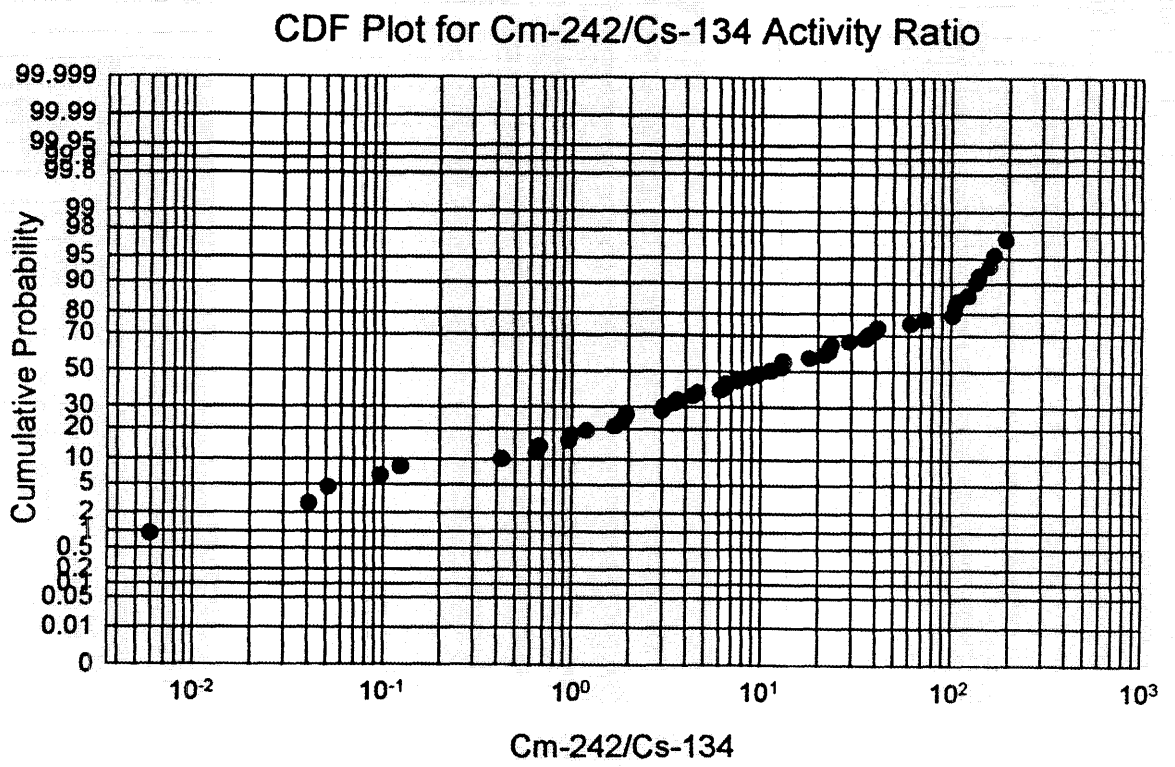
CDF Plot for Am-241/Cs-134 Activity Ratio



CDF Plot for Am-243/Cs-134 Activity Ratio




CDF Plot for Cf-252/Cs-134 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^0
10^1
10^2
Cf-252/Cs-134


CDF Plot for Cm-242/Cs-134 Activity Ratio
Cumulative Probability
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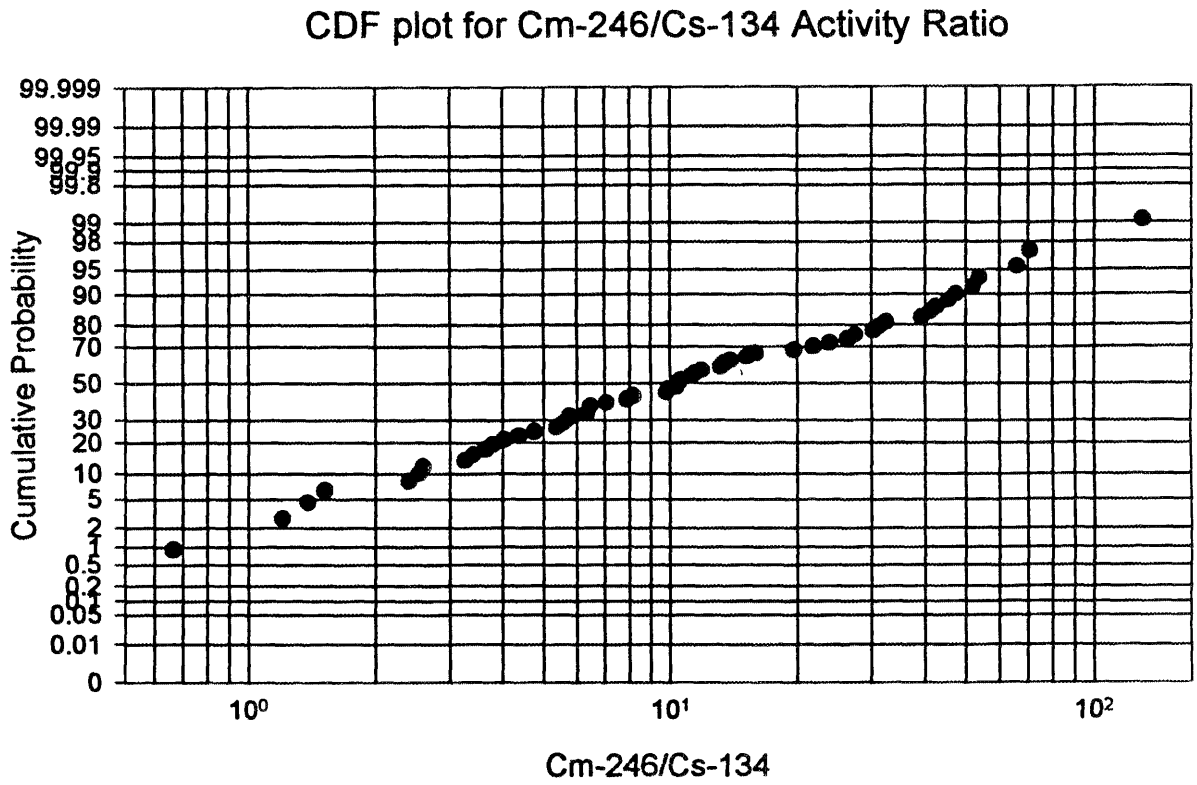
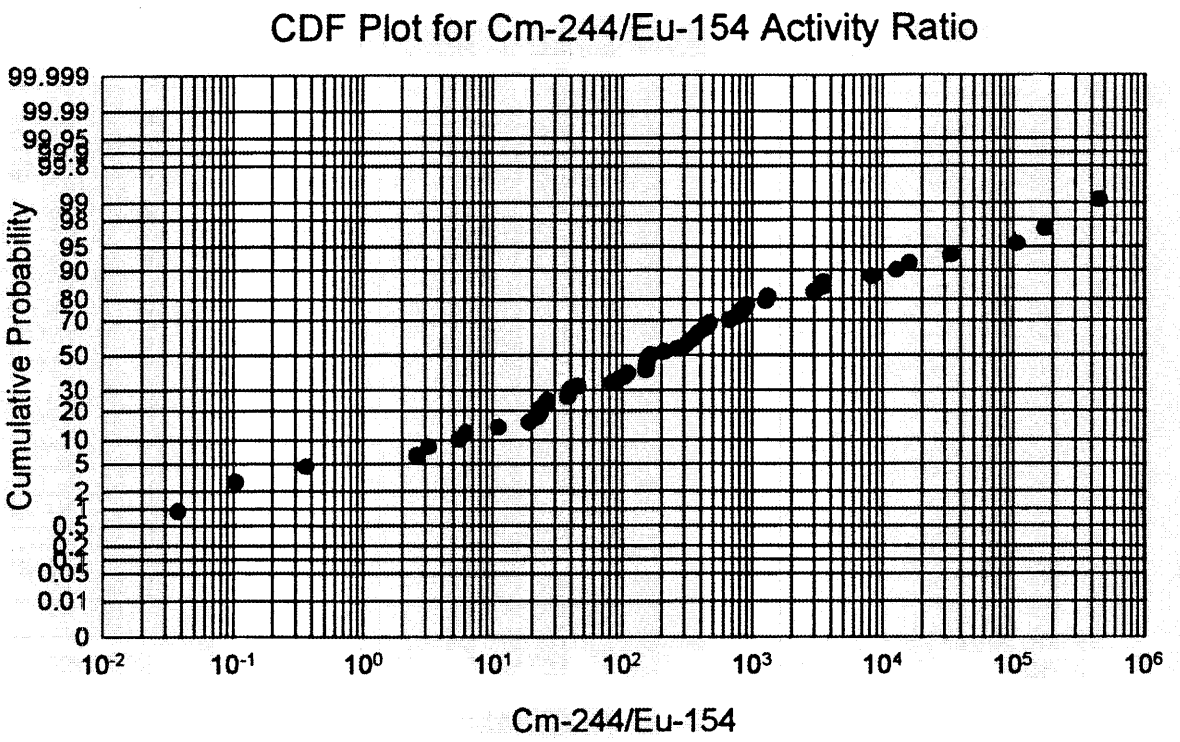
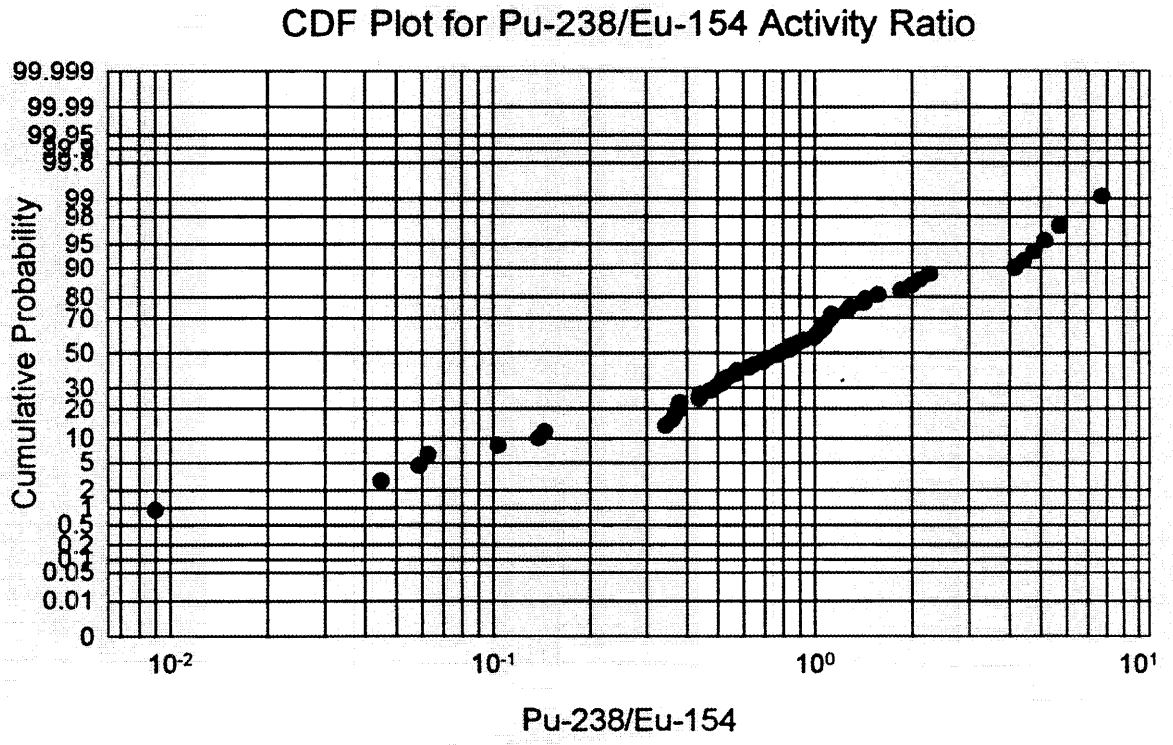
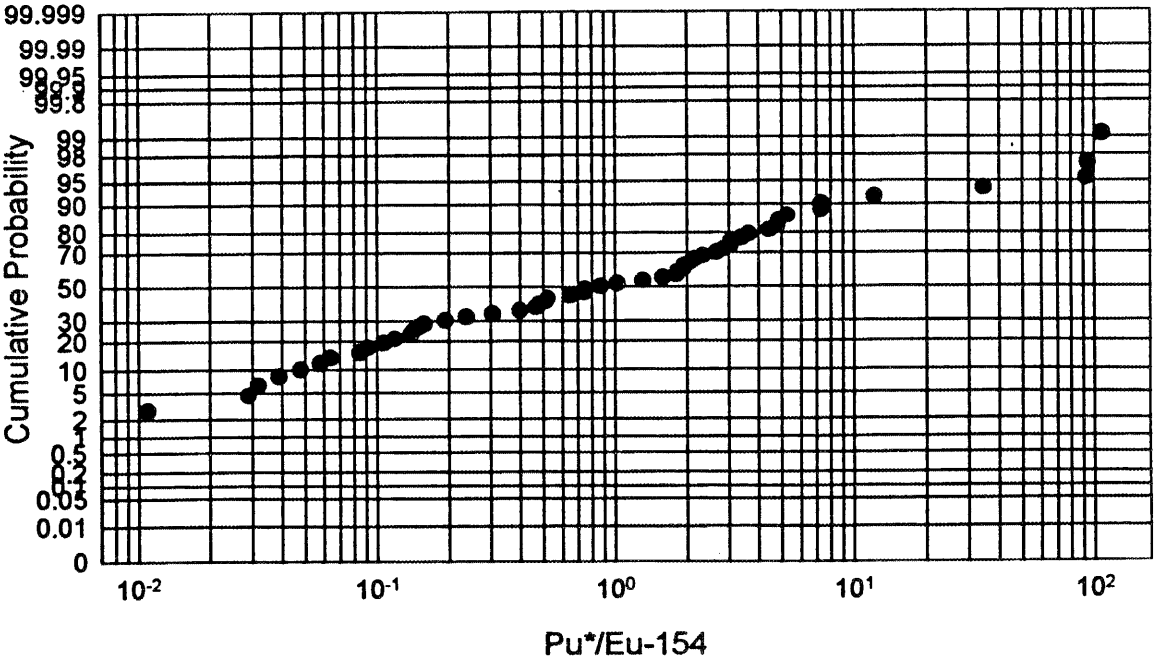
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^0
10^1
10^2
10^3
Cm-242/Cs-134


CDF plot for Cm-246/Cs-134 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^0
10^1
10^2
Cm-246/Cs-134

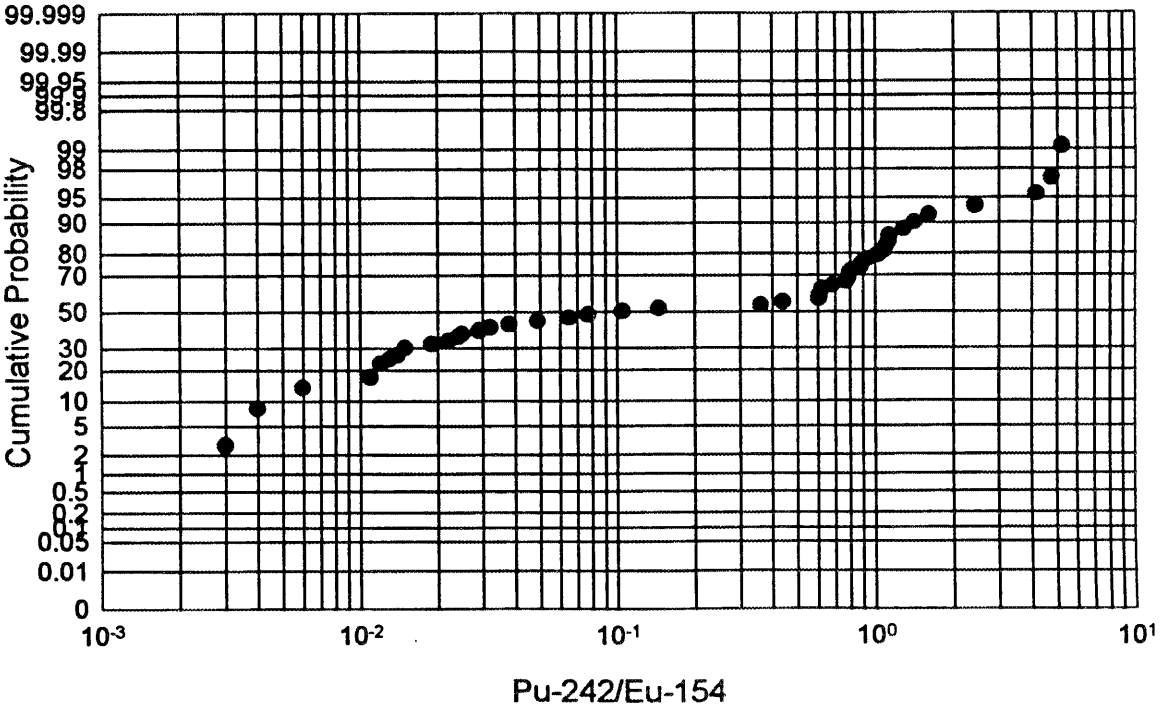

CDF Plot for Cm-244/Eu-154 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
10^{6}
Cm-244/Eu-154

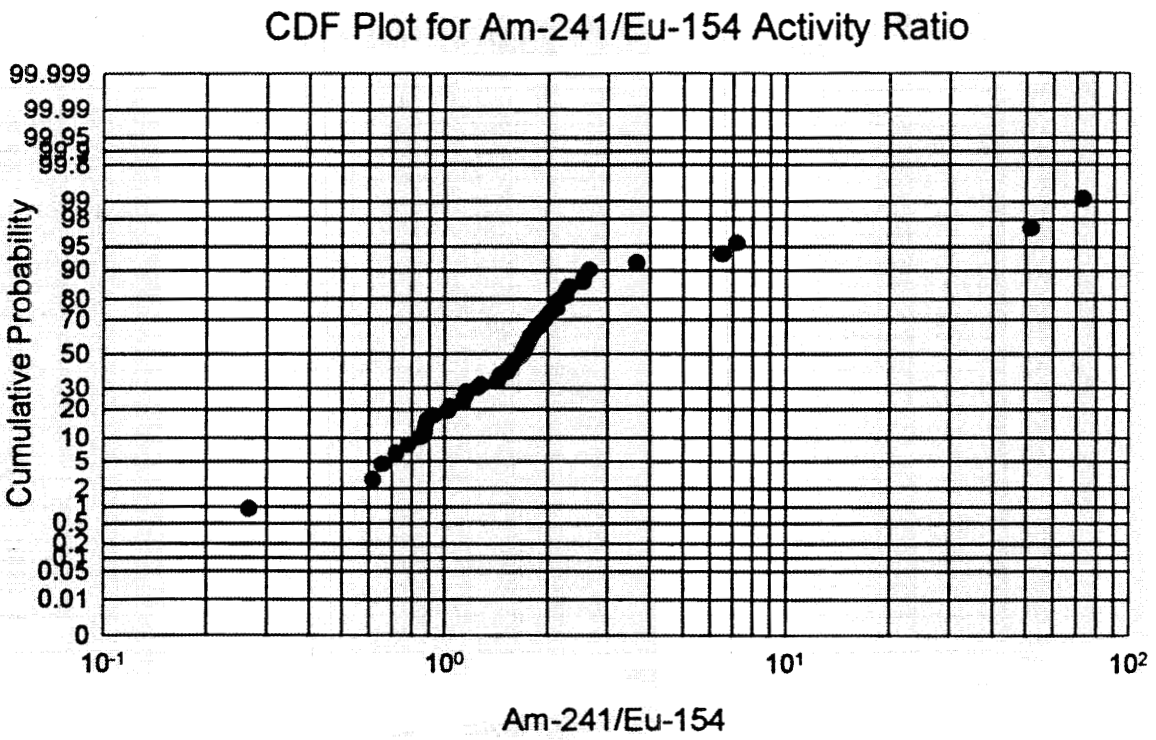

CDF Plot for Pu-238/Eu-154 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.9
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
Pu-238/Eu-154

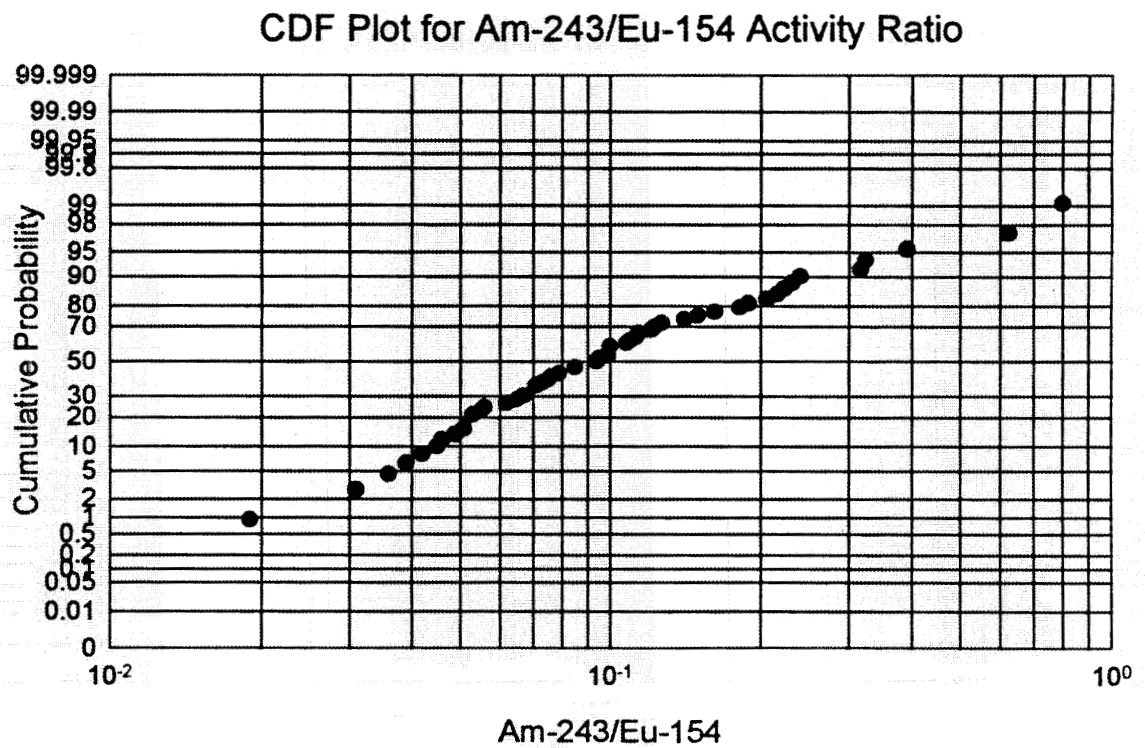
CDF Plot for Pu*/Eu-154 Activity Ratio

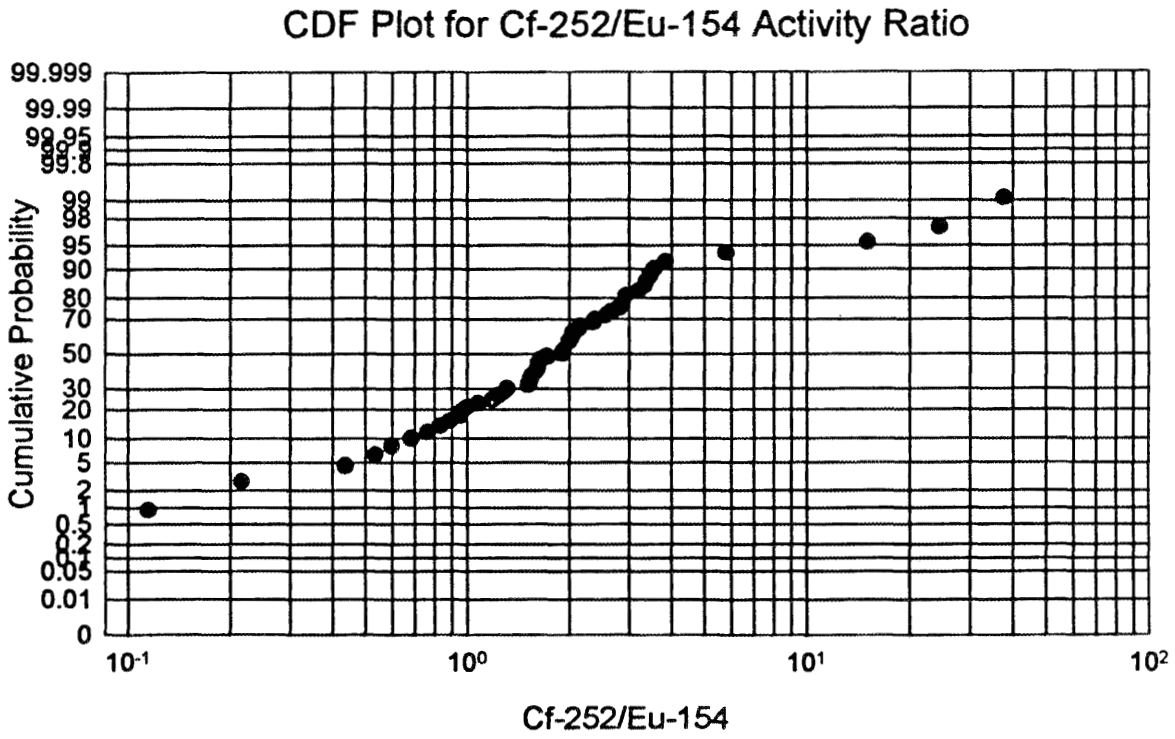


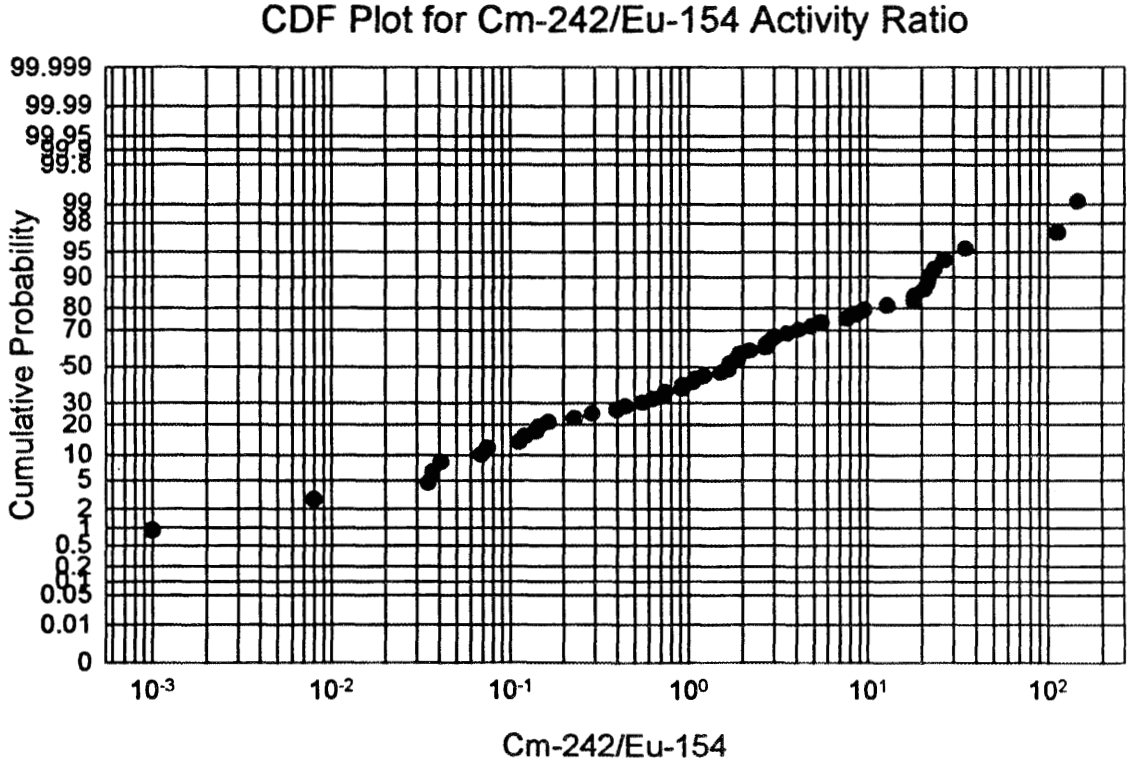
CDF Plot for Pu-242/Eu-154 Activity Ratio

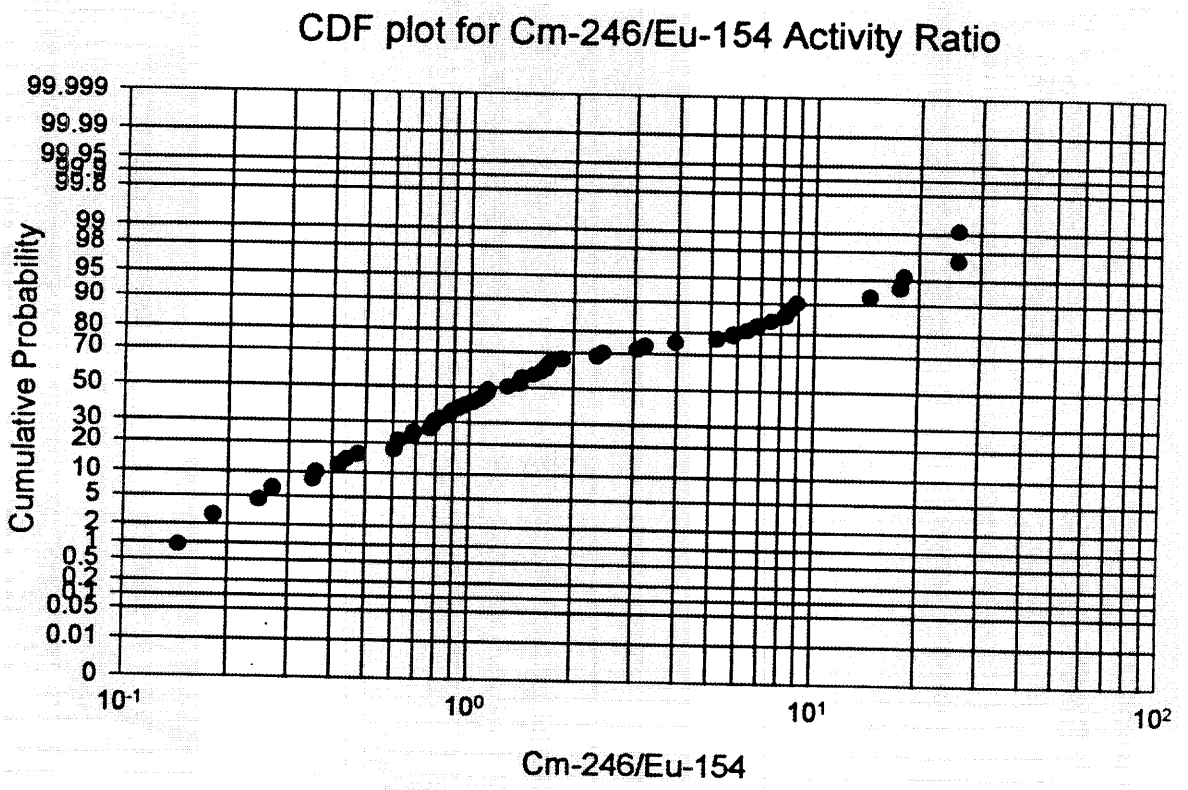



CDF Plot for Am-241/Eu-154 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
10^{2}
Am-241/Eu-154


CDF Plot for Am-243/Eu-154 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
Am-243/Eu-154


CDF Plot for Cf-252/Eu-154 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
10^{2}
Cf-252/Eu-154


CDF Plot for Cm-242/Eu-154 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
Cm-242/Eu-154


CDF plot for Cm-246/Eu-154 Activity Ratio
Cumulative Probability
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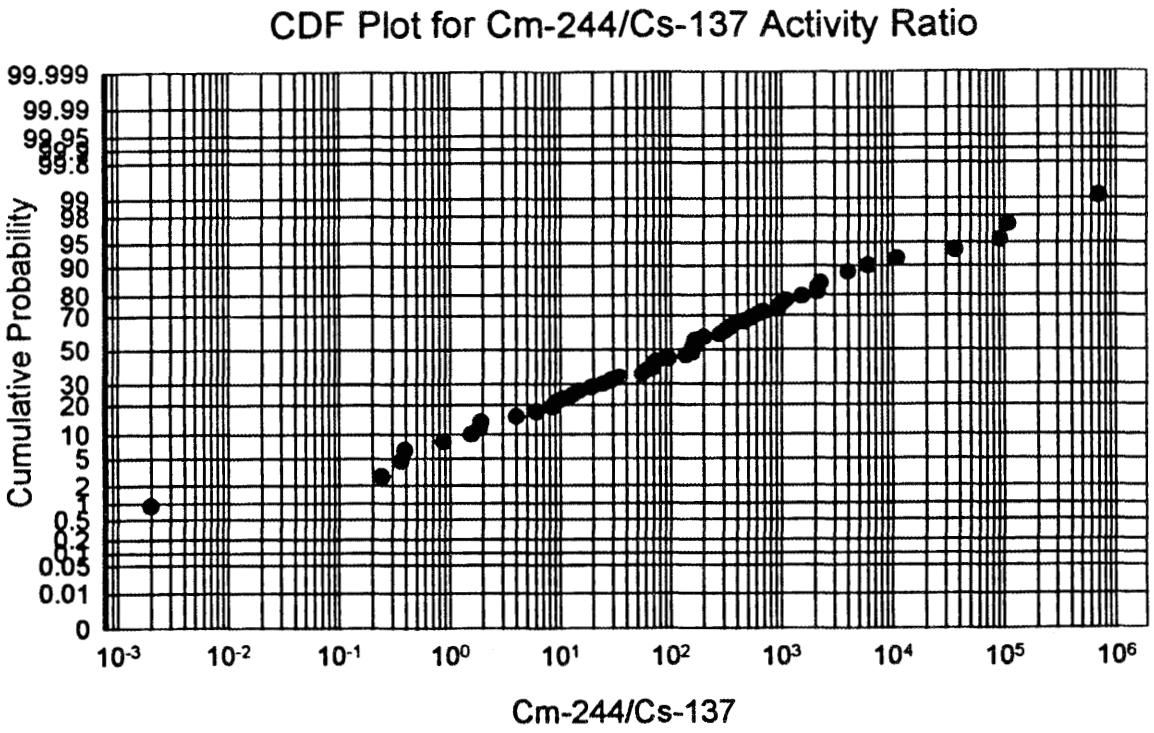
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
10^{2}
Cm-246/Eu-154


CDF Plot for Cm-244/Cs-137 Activity Ratio
Cumulative Probability
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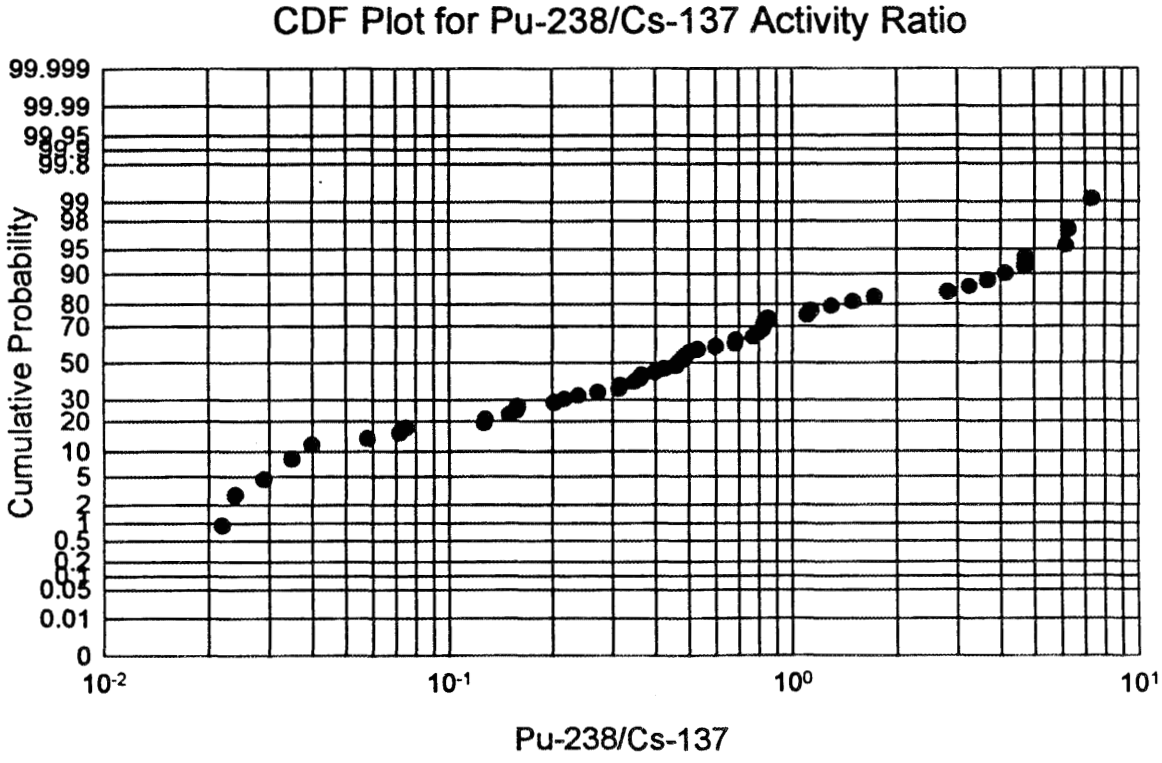
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
10^{6}
Cm-244/Cs-137


CDF Plot for Pu-238/Cs-137 Activity Ratio
Cumulative Probability
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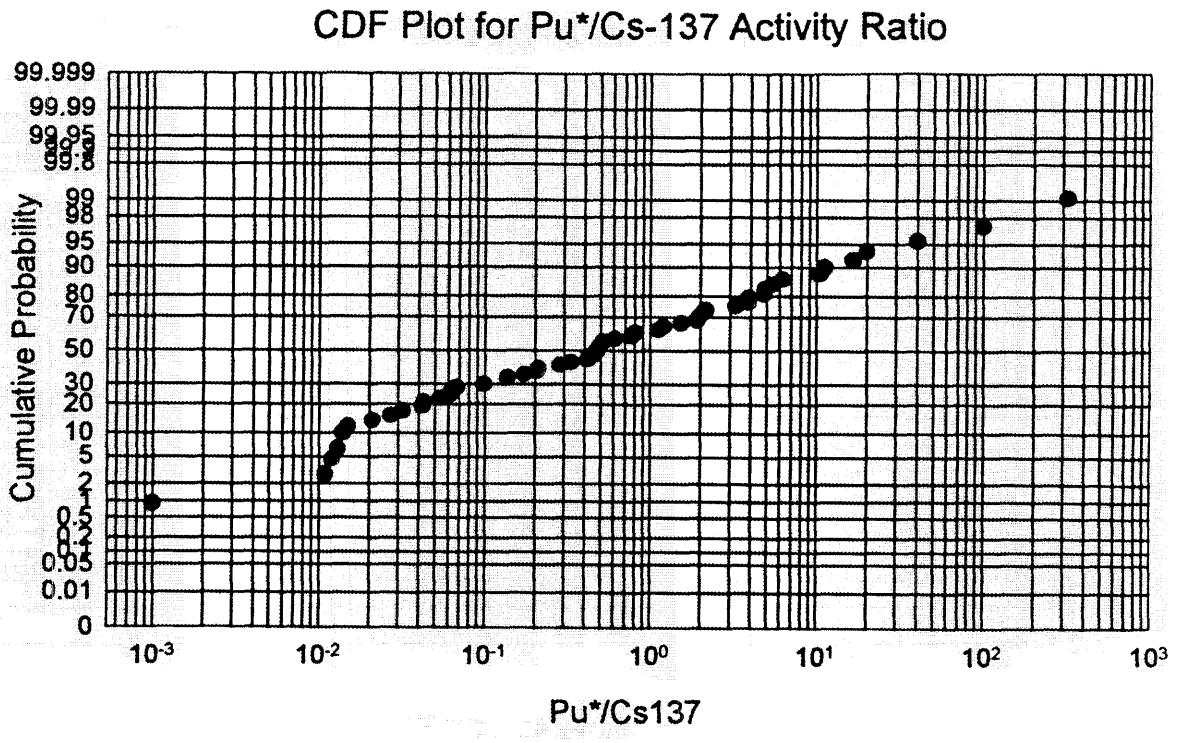
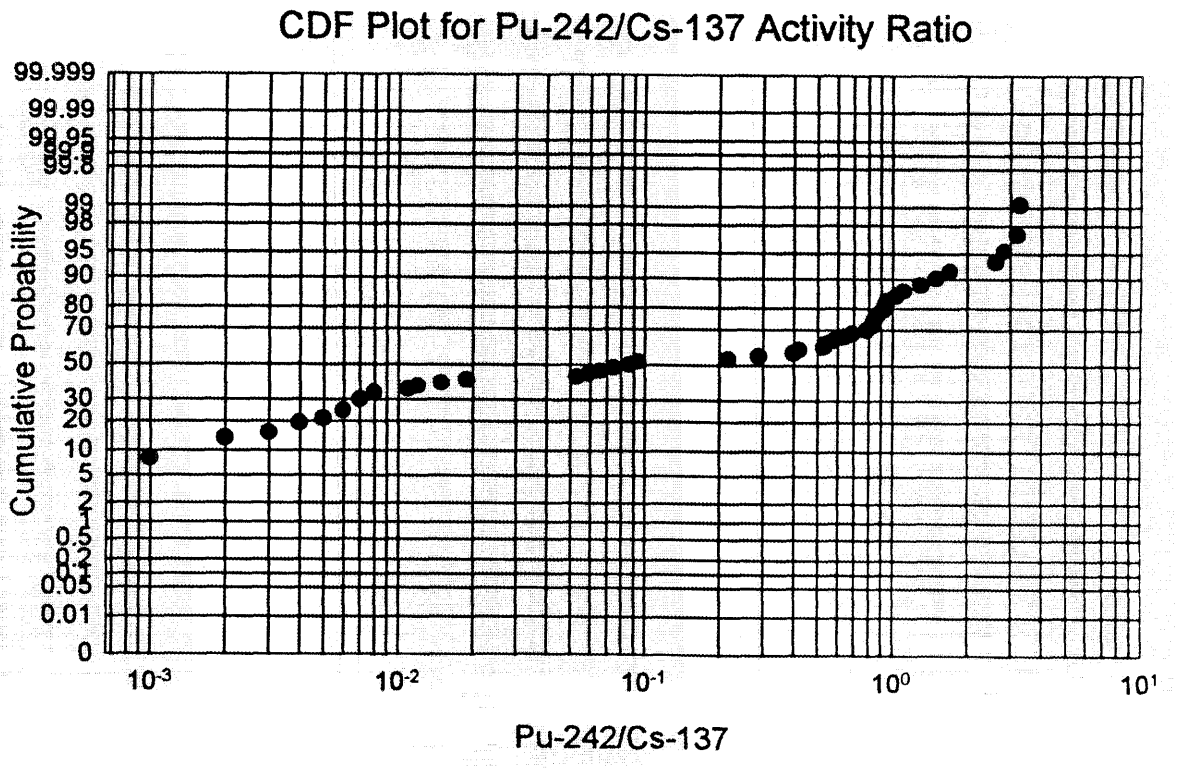
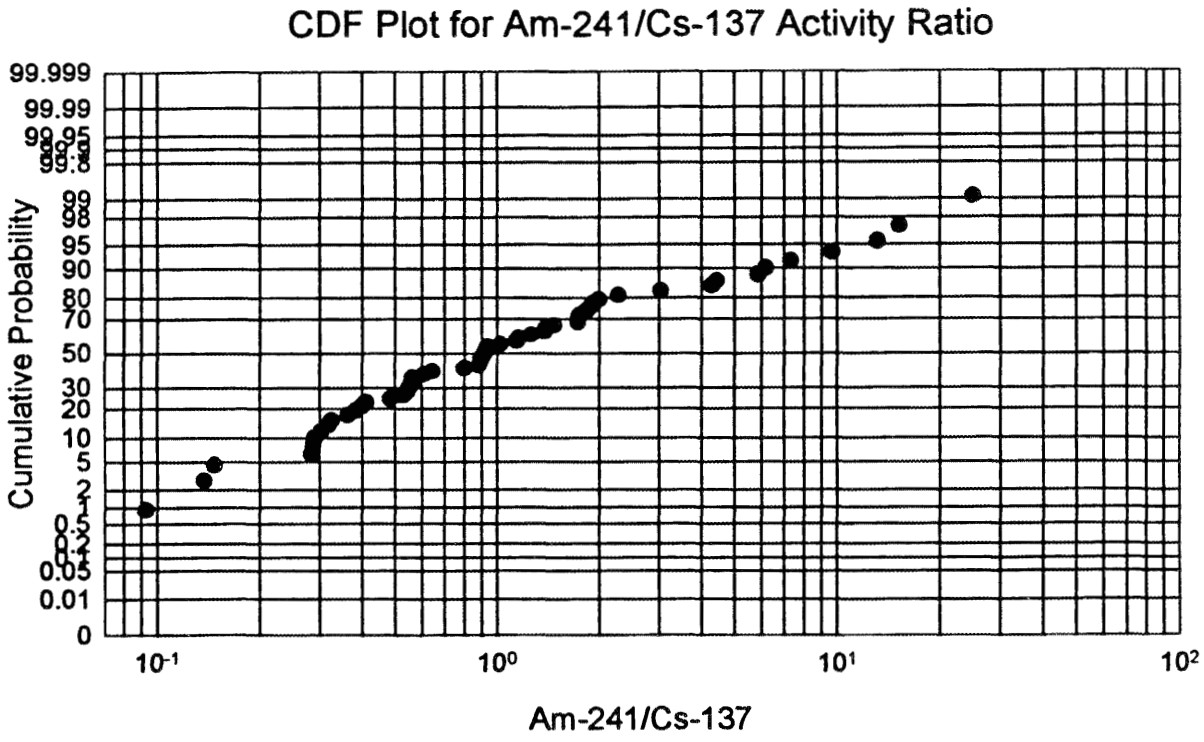
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
10^{1}
Pu-238/Cs-137


CDF Plot for Pu*/Cs-137 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Pu*/Cs137


CDF Plot for Pu-242/Cs-137 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
Pu-242/Cs-137


CDF Plot for Am-241/Cs-137 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
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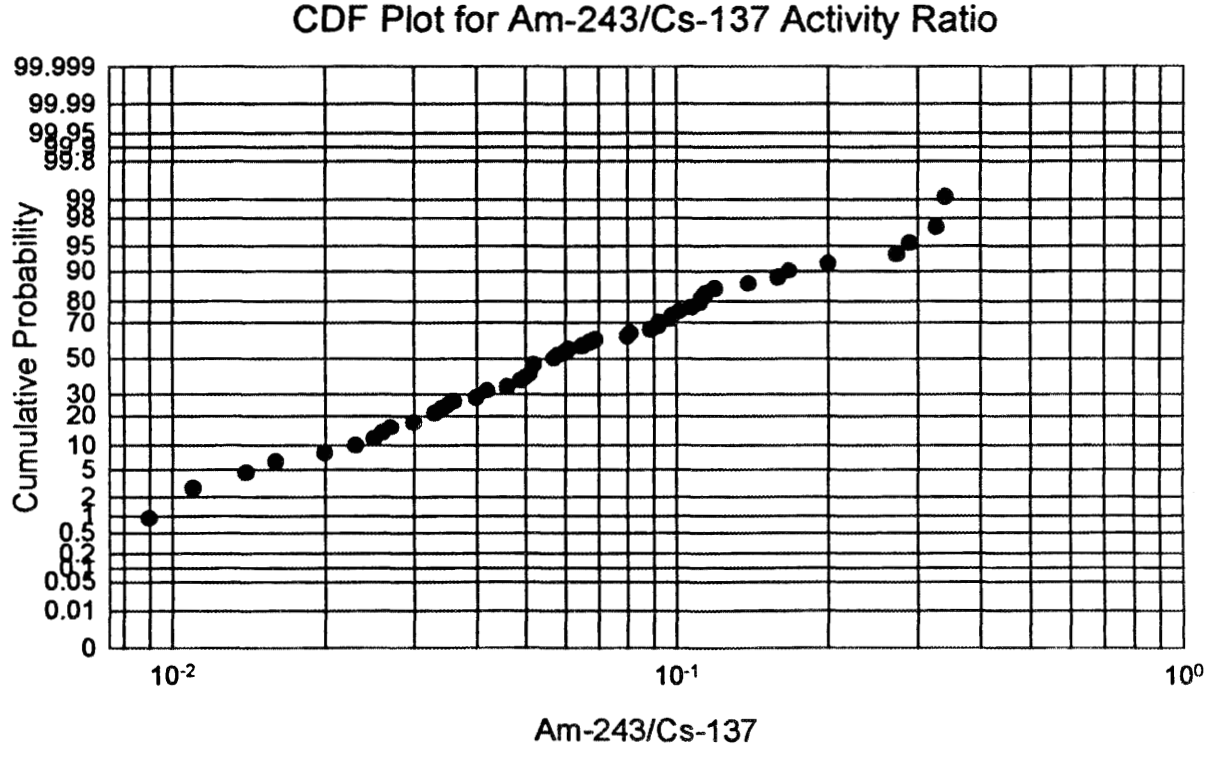
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
10^{2}
Am-241/Cs-137


CDF Plot for Am-243/Cs-137 Activity Ratio
Cumulative Probability
99.999
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
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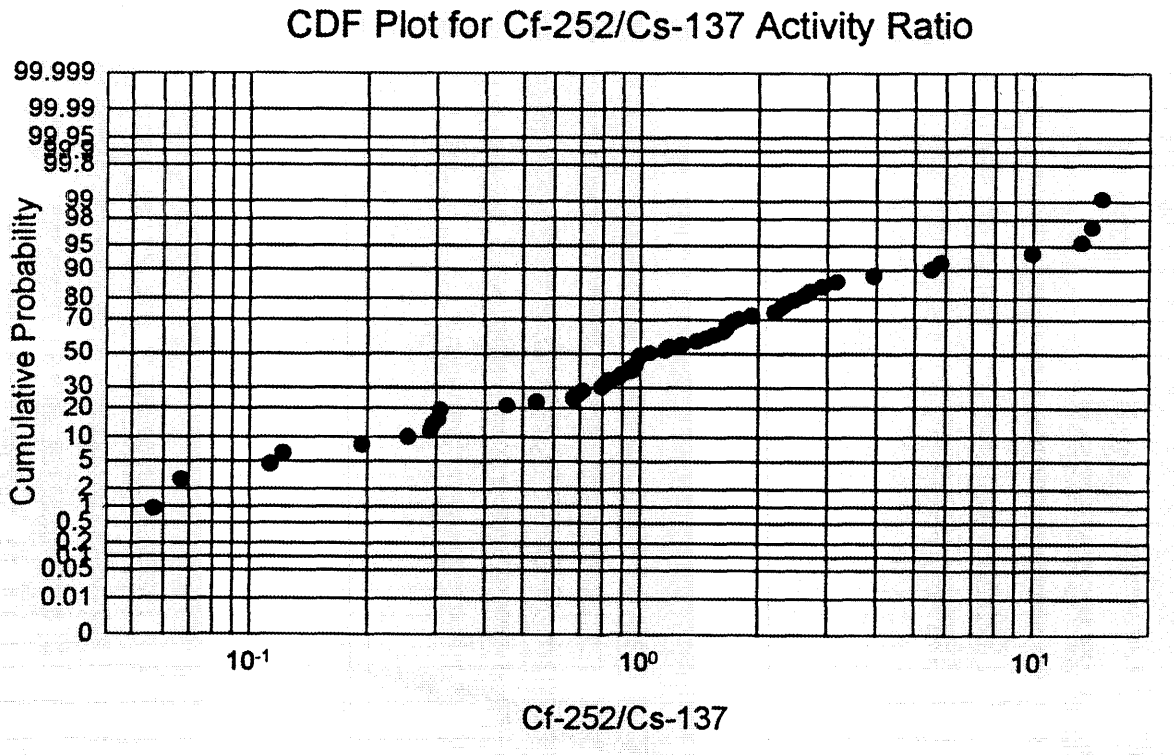
0.1
0.05
0.01
0
10^{-2}
10^{-1}
10^{0}
Am-243/Cs-137


CDF Plot for Cf-252/Cs-137 Activity Ratio
Cumulative Probability
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99.99
99.95
99.8
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98
95
90
80
70
50
30
20
10
5
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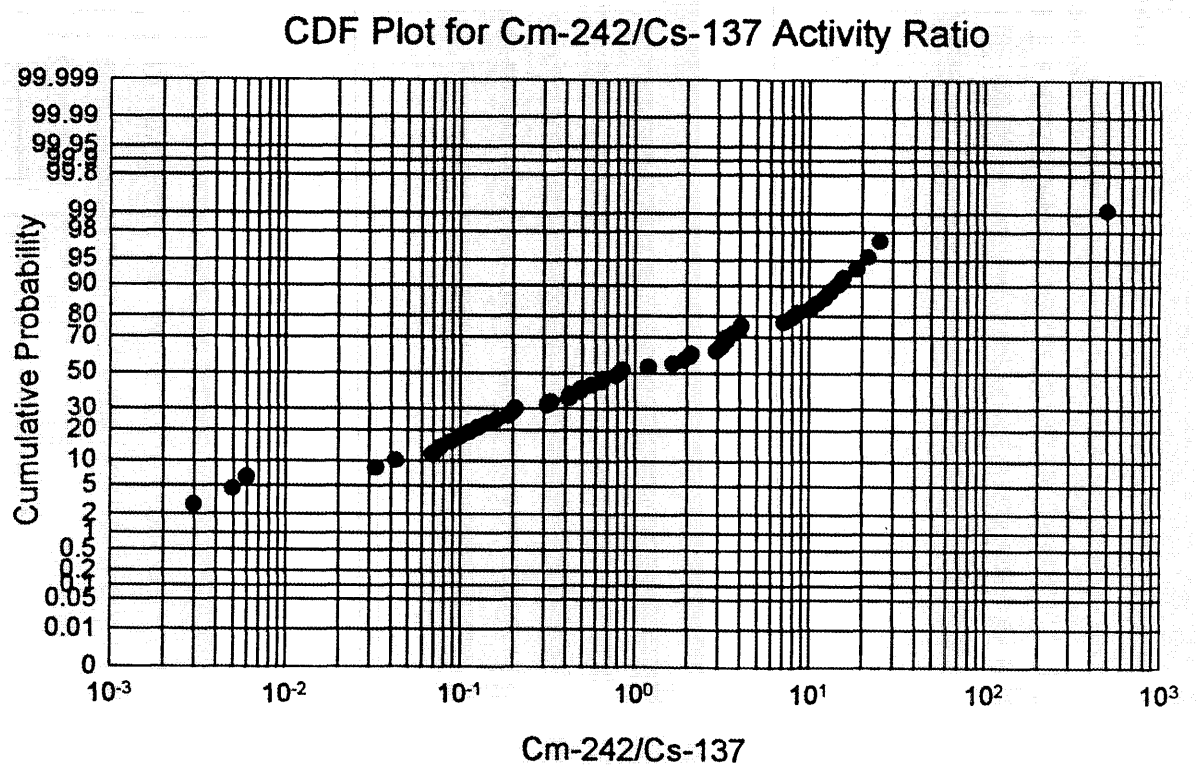
0.5
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
Cf-252/Cs-137


CDF Plot for Cm-242/Cs-137 Activity Ratio
Cumulative Probability
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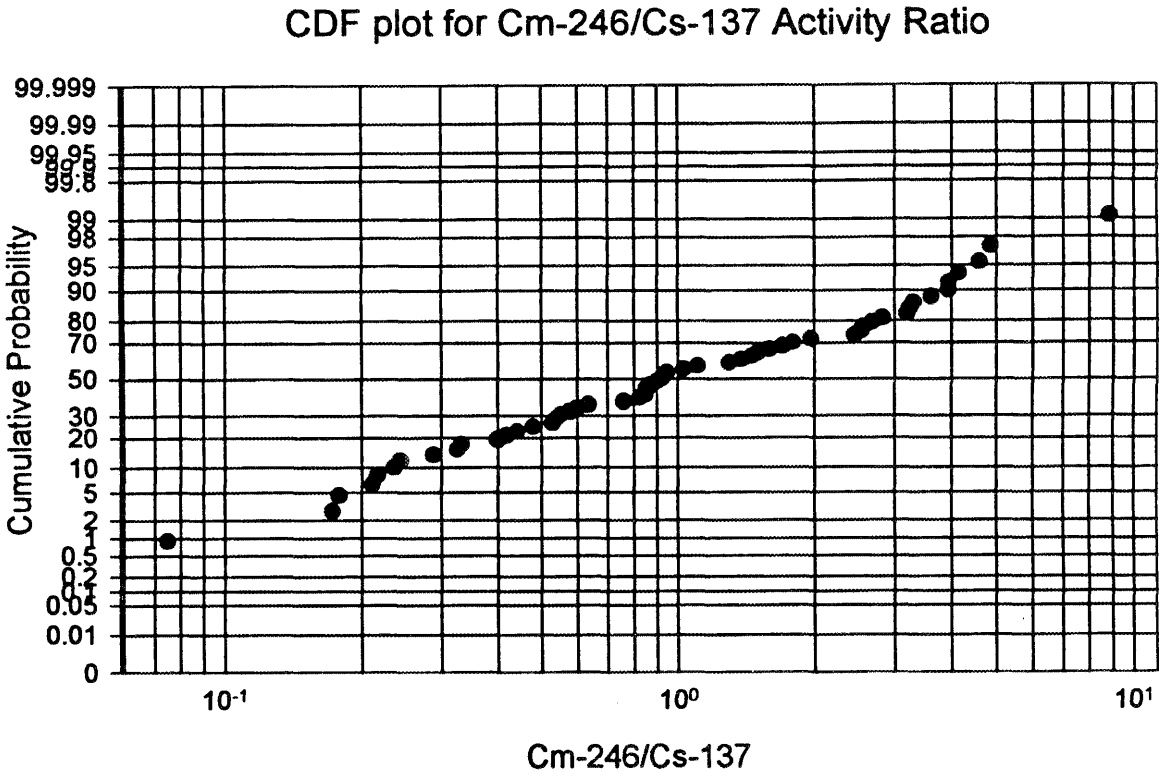
99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
Cm-242/Cs-137


CDF plot for Cm-246/Cs-137 Activity Ratio
Cumulative Probability
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99.99
99.95
99.8
99
98
95
90
80
70
50
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
0
10^{-1}
10^{0}
10^{1}
Cm-246/Cs-137

APPENDIX E
Estimated mean activity ratios and TRU activities for bucket 6120

E1. Activity ratios between selected alpha-emitting radionuclides and Eu-154

	$X_{0.16}(a,g)$	$X_{0.5}(a,g)$	$X_{0.84}(a,g)$	$X_{0.05}(a,g)$	$X_{0.95}(a,g)$	μ_Y	σ_Y^2	μ	σ
Cf-252	0.889	1.909	3.333	0.439	15.106	0.647	0.444	2.383	1.781
Cm-244	19.29	166.67	3,454.45	0.37	1.08E+05	5.116	7.219	6,157.237	2.27E+05
Cm-242	0.121	1.688	18.333	0.035	35.135	0.524	6.341	40.209	956.930
Cm-246	0.477	1.292	7.500	0.247	18.125	0.256	2.098	3.689	9.864
Pu-238	0.361	0.786	2.000	0.059	5.167	-0.241	0.738	1.137	1.188
Pu*	0.085	0.873	4.845	0.029	92.647	-0.136	4.277	7.410	62.455
Pu-242	0.006	0.105	2.426	0.003	4.167	-2.254	9.065	9.762	907.498
Am-241	0.889	1.692	2.326	0.658	7.206	0.526	0.244	1.912	1.005
Am-243	0.051	0.094	0.216	0.036	0.392	-2.364	0.530	0.123	0.102

E2. Activity ratios between selected alpha-emitting radionuclides and Ag-110m

	$X_{0.16}(a,g)$	$X_{0.5}(a,g)$	$X_{0.84}(a,g)$	$X_{0.05}(a,g)$	$X_{0.95}(a,g)$	μ_Y	σ_Y^2	μ	σ
Cf-252	6.522	37.500	107.407	1.758	221.429	3.624	2.132	108.906	296.940
Cm-244	185.185	3.79E+03	9.29E+04	4.839	1.86E+06	8.239	9.690	4.81E+05	6.12E+07
Cm-242	1.313	43.137	258.824	0.136	615.385	3.764	8.801	3,515.420	286,465.150
Cm-246	6.000	30.000	108.333	1.000	500.000	3.401	2.131	87.083	237.306
Pu-238	2.174	17.297	48.571	0.214	100.000	2.851	2.833	71.303	285.149
Pu*	1.486	13.000	192.982	0.145	392.857	2.565	6.090	273.140	5,732.372
Pu-242	0.167	1.000	50.000	0.020	78.571	0.000	11.102	257.516	66,313.847
Am-241	7.083	40.323	107.273	1.000	407.407	3.697	2.043	112.019	290.331
Am-243	0.533	1.930	5.786	0.073	10.556	0.658	1.432	3.950	7.053

E3. Activity ratios between selected alpha-emitting radionuclides and Ru-106

	$X_{0.16}(a,g)$	$X_{0.5}(a,g)$	$X_{0.84}(a,g)$	$X_{0.05}(a,g)$	$X_{0.95}(a,g)$	μ_Y	σ_Y^2	μ	σ
Cf-252	0.489	1.684	4.211	0.15	7.381	0.521	1.187	3.048	4.598
Cm-244	51.852	171.875	546.667	2.615	2300	5.147	1.388	343.963	596.254
Cm-242	0.276	1.431	4.082	0.041	10.667	0.358	1.935	3.765	9.162
Cm-246	0.316	1.3	5.324	0.04	17.727	0.262	1.994	3.523	8.875
Pu-238	0.071	0.647	3.864	0.026	5.833	-0.435	4.083	4.982	38.042
Pu*	0.235	0.816	2.611	0.026	3.316	-0.203	1.452	1.686	3.049
Pu-242	0.004	0.059	2.143	0.0009	4.839	-2.830	10.498	11.233	2,138.694
Am-241	0.379	1.467	5.714	0.081	20	0.383	1.840	3.682	8.475
Am-243	0.019	0.09	0.259	0.009	0.545	-2.408	1.787	0.220	0.491

E4. Activity ratios between selected alpha-emitting radionuclides and Sb-125

	$X_{0.16}(a,g)$	$X_{0.5}(a,g)$	$X_{0.84}(a,g)$	$X_{0.05}(a,g)$	$X_{0.95}(a,g)$	μ_Y	σ_Y^2	μ	σ
Cf-252	2.353	4.714	13.333	1.040	24.483	1.551	0.778	6.956	7.547
Cm-244	30.667	666.667	8750	5	2.07E+05	6.502	8.170	39,626.109	2.36E+06
Cm-242	0.372	5.429	53.333	0.054	91.667	1.692	6.261	124.235	2,840.206
Cm-246	1.319	4.833	14.000	0.717	76.471	1.575	1.411	9.788	17.236
Pu-238	0.690	1.500	4.200	0.140	17.500	0.405	0.830	2.272	2.583
Pu*	0.179	1.792	35.000	0.048	124.000	0.583	7.251	67.262	2,523.756
Pu-242	0.015	0.276	5.238	0.007	15.000	-1.287	8.573	20.067	1,458.839
Am-241	2.209	4.294	13.333	1.000	60.000	1.457	0.858	6.593	7.681
Am-243	0.128	0.291	0.571	0.054	1.550	-1.234	0.563	0.386	0.335

E5. Activity ratios between selected alpha-emitting radionuclides and Cs-134

	$X_{0.16}(a,g)$	$X_{0.5}(a,g)$	$X_{0.84}(a,g)$	$X_{0.05}(a,g)$	$X_{0.95}(a,g)$	μ_Y	σ_Y^2	μ	σ
Cf-252	4.565	11.364	30	1.103	125	2.430	0.887	17.707	21.159
Cm-244	67.742	2020.202	2.36E+04	3.793	1.00E+06	7.611	9.195	2.00E+05	1.99E+07
Cm-242	0.97	11.31	108.333	0.052	169.231	2.426	5.582	184.337	2,998.780
Cm-246	3.409	10.51	41.25	1.385	66.129	2.352	1.572	23.068	45.070
Pu-238	0.667	5.231	31.25	0.393	78.571	1.655	3.735	33.863	216.576
Pu*	0.355	5.328	67.308	0.171	333.333	1.673	6.897	167.561	5,266.984
Pu-242	4.64	9.78	50	2.448	30.263	2.280	1.648	22.294	45.671
Am-241	4.384	8.7	59.036	2.138	175.758	2.163	2.185	25.943	72.879
Am-243	0.3	0.615	1.455	0.145	3.5	-0.486	0.627	0.842	0.786

E6. Activity ratios between selected alpha-emitting radionuclides and Cs-137

	$X_{0.16}(a,g)$	$X_{0.5}(a,g)$	$X_{0.84}(a,g)$	$X_{0.05}(a,g)$	$X_{0.95}(a,g)$	μ_Y	σ_Y^2	μ	σ
Cf-252	0.304	1.059	2.923	0.113	13.333	0.057	1.296	2.025	3.299
Cm-244	4.038	159.091	2280.702	0.367	92857.143	5.069	10.830	3.58E+04	8.04E+06
Cm-242	0.088	0.826	11.111	0.005	21.765	-0.191	5.931	16.025	310.467
Cm-246	0.326	0.923	3.239	0.179	4.603	-0.080	1.331	1.796	2.998
Pu-238	0.072	0.467	2.823	0.029	6.19	-0.761	3.367	2.515	13.310
Pu*	0.027	0.479	5.429	0.012	40.404	-0.736	7.165	17.225	619.187
Pu-242	0.003	0.087	1.03	0.0005	2.823	-2.442	9.099	8.230	778.464
Am-241	0.326	0.919	4.308	0.148	13.175	-0.084	1.749	2.204	4.804
Am-243	0.027	0.057	0.119	0.014	0.29	-2.865	0.550	0.075	0.064

E7. TRU activities in REDC waste bucket 6120 based on estimated mean activity ratios

a) Without weighting factor:

		Ru-106			Ag-110m			Sb-125			Cs-134			Eu-154			Cs-137		
Cf252	(µCi)	1,038.78	±	163.81	132.87	±	33.08	3,669.50	±	534.33	376.96	±	85.98	1,159.68	±	231.07	637.09	±	207.02
Cm244	(µCi)	225,635.41	±	76,107.61	30,609.54	±	15,587.26	565,812.01	±	164,923.48	56,003.58	±	17,837.90	270,173.64	±	88,630.47	65,453.38	±	26,860.17
Cm242	(µCi)	933.73	±	168.93	119.75	±	33.37	3,354.28	±	687.81	306.12	±	63.01	1,055.36	±	206.48	458.82	±	137.72
Cm246	(µCi)	1,038.78	±	332.40	170.90	±	120.38	3,770.04	±	1,861.95	434.53	±	213.19	1,890.06	±	1,024.79	502.44	±	322.29
Pu238	(µCi)	537.97	±	110.81	75.23	±	20.83	1,572.23	±	344.31	197.78	±	56.64	562.76	±	110.51	328.92	±	132.12
Pu*	(µCi)	531.22	±	103.32	69.17	±	21.35	1,277.92	±	172.43	136.06	±	21.24	693.71	±	132.37	229.08	±	69.04
Pu242	(µCi)	8.46	±	1.85	1.11	±	0.32	29.38	±	8.25	3.40	±	1.06	10.28	±	2.13	4.94	±	2.33
Am241	(µCi)	1,846.66	±	650.75	249.14	±	117.45	5,640.62	±	1,610.43	560.16	±	167.18	1,834.25	±	733.28	692.75	±	268.70
Am243	(µCi)	61.13	±	11.27	9.04	±	2.39	175.15	±	19.91	16.53	±	2.61	61.24	±	8.87	23.61	±	4.79
TRU activity	(µCi)	4,024.211	±	746.361	574.596	±	170.822	1.25E+04	±	2.49E+03	1.35E+03	±	2.78E+02	5.05E+03	±	1.27E+03	1.78E+03	±	4.45E+02
Total activity	(µCi)	2.32E+05	±	7.61E+04	3.14E+04	±	1.56E+04	5.85E+05	±	1.65E+05	5.80E+04	±	1.78E+04	2.77E+05	±	8.86E+04	6.83E+04	±	2.69E+04
TRU conc.	(nCi/g)	1,877.62	±	348.24	268.10	±	79.70	5,816.09	±	1,162.63	629.17	±	129.52	2,357.31	±	593.44	831.33	±	207.78

b) With weighting factors:

		Ru-106			Ag-110m			Sb-125			Cs-134			Eu-154			Cs-137		
Cf252	(µCi)	17.008	±	2.553	0.929	±	0.225	288.251	±	12.621	3.476	±	0.235	51.699	±	3.936	1.342	±	0.322
Cm244	(µCi)	369.373	±	102.620	8.395	±	5.143	5.08E+04	±	2.24E+03	371.794	±	3422.892	459.346	±	80.690	434.182	±	80.987
Cm242	(µCi)	6.873	±	1.333	0.852	±	0.212	307.340	±	13.540	2.098	±	0.113	13.368	±	1.466	1.039	±	0.259
Cm246	(µCi)	0.077	±	0.055	0.013	±	0.011	328.321	±	15.300	0.023	±	0.000	0.035	±	0.021	0.054	±	0.031
Pu238	(µCi)	0.368	±	0.150	0.032	±	0.019	165.901	±	7.315	0.259	±	0.004	0.000	±	0.000	0.068	±	0.033
Pu*	(µCi)	0.706	±	0.240	0.091	±	0.038	136.103	±	5.958	1.267	±	0.040	0.733	±	0.163	0.345	±	0.100
Pu242	(µCi)	0.014	±	0.004	0.001	±	0.000	2.937	±	0.129	0.002	±	0.000	0.015	±	0.003	0.000	±	0.000
Am241	(µCi)	4.364	±	1.037	0.067	±	0.040	376.331	±	16.528	2.360	±	0.155	46.012	±	3.758	1.686	±	0.385
Am243	(µCi)	0.808	±	0.119	0.009	±	0.004	10.741	±	0.469	0.478	±	0.002	5.087	±	0.099	0.800	±	0.090
TRU activity	(µCi)	6.337	±	1.083	0.213	±	0.060	1,020.335	±	24.423	4.390	±	0.448	51.881	±	3.775	2.953	±	0.411
Total activity	(µCi)	399.591	±	102.666	10.387	±	5.152	5.24E+04	±	2.24E+03	381.758	±	58.510	576.295	±	80.887	439.515	±	80.989
TRU conc.	(nCi/g)	2.96	±	0.51	0.10	±	0.03	476.07	±	11.40	2.05	±	0.21	24.21	±	1.76	1.38	±	0.19

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